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JOURNAL
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STUDIES ON THE BIOLOGY OF GYMNOSPORANGIUM GLOBOSUM FARL.

J. D. MACLACHLAN

With plates 166–175 and two text figures

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I. INTRODUCTION

SINCE the pioneer work of Farlow (1880), who ascertained the alternate hosts of *Gymnosporangium globosum* Farl., many observations on various phases of the biology of this rust have been recorded; these observations, however, do not afford a complete survey of the biology of *G. globosum*. More than one hundred suscepts have been added, since 1880, to the host list, yet observations of the writer warrant the conclusion that the number of suscepts, conservatively estimated, is more than six hundred; moreover, little information was previously available

regarding their relative susceptibility. Many aspects of the progressive development of the symptoms and signs of the diseases caused by this rust have not been described in full; the incompleteness of this knowledge becomes more evident with the increase in the number of known hosts. No definite information has been available concerning the time when the aeciospores of *G. globosum* germinate or the method by which they produce infection on the Juniperus hosts; knowledge with respect to this question is a prerequisite to any attempt to control the rust on the red cedar. Aside from an academic consideration of the biology of *G. globosum,* this rust is of increasing economic importance and is causing great damage to both the ornamental and the orchard hosts in localized areas throughout the eastern part of the United States.

These desiderata have led the writer to investigate more fully the biology of *G. globosum.* A determination of the hosts and their relative susceptibility has already been published (MacLachlan, 1935). The numerous inoculations and field observations that were conducted at that time afforded an opportunity to carry on extensive studies on other aspects of the biology of *G. globosum;* the results of these investigations have been incorporated with those of other writers and are now presented.

II. NOMENCLATURE

The following names, chronologically arranged, have been given to the rust now known as *Gymnosporangium globosum* Farl. The stage in the life cycle of the rust to which the name refers precedes the name.

III **Gymnosporangium globosum** Farl. in Bot. Gaz. **11:** 236, 239 (Sept. 1886).

I *Aecidium Crataegi* var. *Oxyacanthae* Schw. Syn. Fung. Carol. 66 (40), no. 432 (1822).

I *Caeoma Cylindrites* Lk. var. *Crataegi-punctatae* Schw. Syn. Fung. Am. Bor. (Trans. Amer. Phil. Soc. II. **4:** 294, no. 2899a. 1832).

III *Gymnosporangium fuscum* DC. var. *globosum* Farl. Gymnosporangia U. S. 18, pl. 1, f. 7–11 (1880).

III *Gymnosporangium Sabinae* (Dicks.) Wint. var. *globosum* Trel. in Trans. Wisc. Acad. **6:** 133 (29) (July 1866).

III *Gymnosporangium globosum* Farl. in Bot. Gaz. **11:** 236, 239 (Sept. 1886).

I *Roestelia lacerata y* & *z* Thaxt. ex Farl. in Bot. Gaz. **11:** 240 (Sept. 1886).

I *Gymnosporangium globosum* I Thaxt. in Rept. Conn. Exper. Sta. **14:** 98 (20) (1891).

I *Roestelia globosa* Shear, N. Y. Fungi Exsicc. no. 79 (1893). Corrected label.

III *Puccinia globosa* Kuntze, Rev. Gen. Pl. **3**[2]: 507 (1898).
III *Roestelia globosa* III Kuntze in Bot. Centralbl. **77**: 300 (15 Feb. 1899).
III *Tremella globosa* Arth. in Proc. Ind. Acad. 1900: 136 (June 1901).
I *Aecidium globosum* Farl. Bibl. Index N. Amer. Fungi, 49 (1905).
III *Aecidium globosum* Arth. in Result. Sci. Congr. Bot. Wien, 1905: 343 (1906).

The names *Gymnosporangium globosum* Farl. and *Roestelia globosa* Shear stand as the authentic names for the III and I stages, respectively. The name *Gymnosporangium globosum* Farl. is now accepted as referring to either stage of the rust and is so used throughout this presentation.

III. RANGE AND ECONOMIC IMPORTANCE OF G. GLOBOSUM

A difficulty in determining the exact range and economic importance of *G. globosum* arises due to the many reports in the literature which refer collectively to the three rusts, *G. globosum, G. Juniperi-virginianae,* and *G. clavipes.* Nevertheless, sufficient evidence is extant to make possible accurate determinations of both range and economic importance of *G. globosum.*

Gymnosporangium globosum is confined in its range to the eastern and central parts of United States and to the southern parts of Ontario and Quebec. In Fig. 1 the distribution by states has been plotted; the circles and dots indicate the states in which the diseases caused by this rust have been reported on the Juniperus and pomaceous hosts, respectively.

A review of the literature indicates that the prevalence of this rust is steadily increasing; several factors may be involved in this phenomenon. Jones and Bartholomew (1915) offer the suggestion that the alternate hosts, the red cedar and the wild pomaceous hosts such as crab-apples and hawthorns, multiply more rapidly in open pastures and waste cut-over lands than they did in the original forests. The orchardist and ornamentalist, as well as bringing the alternate hosts closer together, have introduced on their estates many susceptible pomaceous trees that may serve as hosts. Whether or not the rust is increasing in virulence is open to question.. The rapid increase in scientific investigation during recent years, which brings to light new host species and through the discovery of these has extended the known range of the diseases caused by this rust, may give an appearance of increased prevalence and virulence.

Gymnosporangium globosum is causing more damage in some states

than in others; this, as well, may be due to the influence of man, who is constantly bringing into close range of each other, susceptible alternate hosts of the rust. In the eastern part of New York State, for example, this rust is almost on a par with *G. Juniperi-virginianae* with respect to the damage which it is causing. Stewart (1910) reports severe infection on Kieffer pears in an orchard at Long Island. According to W. D. Mills (Haskell, 1929) *G. globosum* was unusually prevalent in Duchess and Greene counties on the foliage of pears in 1928. Thomas and Mills (1929a) consider *G. globosum* as one of the three rusts (*G.*

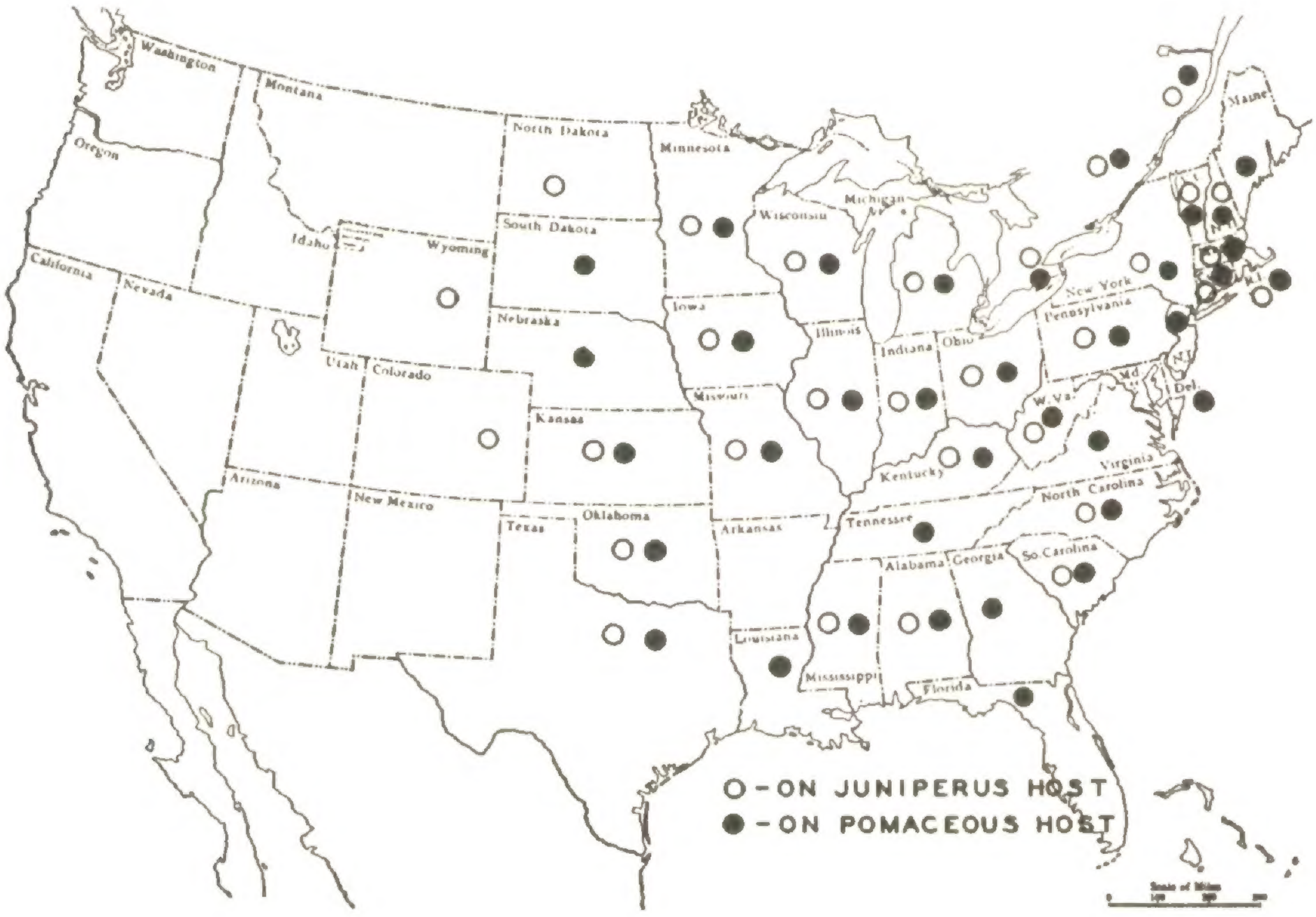

FIG. 1. DISTRIBUTION OF GYMNOSPORANGIUM GLOBOSUM BY STATES

globosum, *G. Juniperi-virginianae* and *G. clavipes*) destructive to apples in eastern New York State and report the occurrence of *G. globosum* on at least thirteen varieties of apples, with severe infection in some instances. In 1930 they (Thomas and Mills, 1930) list twenty-three varieties of apples on which the disease caused by this rust has been found. H. E. Thomas in a letter, dated Aug. 27, 1930, to the Plant Disease Reporter (Anonymous, 1930) writes that *G. globosum* was more common that year on the foliage of apples in Essex County than was *G. Juniperi-virginianae*. Another report (Anonymous, 1930) by W. S. Fields states that all the Crataegus plants of all kinds on an estate at Locust Valley, Long Island, were heavily infected. Other writers who have reported this rust in New York State include Grier (1925),

Martin (1925), Salisbury (1929), Crosby, Mills and Blauvelt (1929), Barrus, Boyd and Wood (1931) and Miller, Stevens and Wood (1933).

Severe local infections have been observed by the writer in eastern Massachusetts. Loci of infection may be found on estates where susceptible ornamental Crataegi are planted in vicinities that embrace the red cedar, and in open pastures and waste lands where wild Crataegus and Malus species are within close range of the cedar. Apparently no serious outbreaks of the diseases caused by this rust have occurred, as yet, in commercial orchards in Massachusetts.

States in which severe to moderately severe local infections have been reported include Connecticut (Clinton, 1903), Florida (Martin, 1925), Illinois (verbal report from Morton Arboretum), Michigan (Martin, 1923), Minnesota (Martin, 1920) and Ohio (Martin, 1923). Bliss (1933) states that this rust is common on apple in Indiana.

Reports would indicate that the rust is not of great economical importance in Alabama (Underwood and Earle, 1897), Iowa (Bliss, 1933), Kansas (Bartholomew, 1899), Maine (Morse and Lewis, 1910) (Miller, Stevens and Wood, 1933), New Jersey (Cook, 1917), Ontario (Connors, 1934), Wisconsin (Jones and Bartholomew, 1915) and Vermont (Anonymous, 1928). Martin (1925) reports *G. globosum* as occurring in Alaska.

IV. SYMPTOMATOLOGY OF THE DISEASES CAUSED BY G. GLOBOSUM

A. On Pomaceous Hosts

Observations were made concerning the progressive development of the symptoms and signs of the diseases caused by *G. globosum* as they appeared on the inoculations of the respective pomaceous hosts (MacLachlan, 1935). For the sake of convenience the progressive development of the symptoms and signs will be considered from both the morphological and histological viewpoints as they appeared on the foliage of *Crataegus;* modifications of these symptoms and signs as they appeared on the foliage of other hosts and on the flowers, fruit and twigs, will follow; additional observations made by other writers will be included throughout the presentation.

(a) On the foliage of *Crataegus*.

The first morphological evidence of the disease caused by this rust is the exhibition of very small light-colored areas or flecks on the upper surface of the leaf. These appear within ten to twelve days after inoculation. In rare cases no further symptoms ever occur except that the

flecks may turn brown; normally, though, these flecks become more distinct and within approximately fifteen days after inoculation (see Table I) they show as bright yellow lesions varying from one to more than ten millimeters in diameter. Sections at this stage of development reveal intercellular hyphae among the palisade and mesophyll cells (Plate 168, Fig. 5) as well as densely intertwined masses of hyphae between the epidermis and palisade layer. These masses of hyphae are the spermogonia primordia which develop to form the mature spermogonia approximately twenty-three days after inoculation (see Table I).

The mature spermogonia appear on the upper surface of the leaf, rarely on the lower, as small raised points in the center of the lesion. On rupturing the epidermis of the leaf the spermogonia exude a sticky fluid in which abundant spermatia may be found. In Plate 173, Fig. 1 may be seen a photograph of these spermatia (mag. × 545), obtained by placing a drop of the spermogonial fluid on a glass slide. Weimer (1917b) has illustrated the type of spermogonium in cross section.

TABLE I

DATA ON THE TIME OF OCCURRENCE OF THE SYMPTOMS AND SIGNS OF THE DISEASE CAUSED BY G. GLOBOSUM ON THE FOLIAGE OF CRATAEGUS[1]

	No. days after inoculation			No.
Symptoms and signs	minimum	maximum	average	species
1st appearance of lesion	13	22	15.1	38
1st exudation of spermogonial fluid	17	30	22.7	39
Spermogonia turned black	28	54	41.5	35
1st appearance of swelling	47	59	53.6	31
1st appearance of aecia	72	111	96.0	48

Exudation of the spermogonial fluid continues for approximately twenty days (see Table I), following which the spermogonia turn black and are quite conspicuous on the yellowish background (Plate 171, Fig. 1). Other than the color change of the spermogonia, little change in the lesion can be noted except for the formation, in many instances, of reddish borders around the lesions. These borders while manifested to a greater extent on some hawthorns than on others are not consistently formed even on a single host. Severe infections where more than fifty percent of the leaf area is diseased may cause yellowing of the leaf and defoliation at this stage in the development of the rust; scattered in-

[1]These data were obtained from typical representatives of the various groups of *Crataegus* inoculated with *G. globosum* Farl. in May, 1932.

fections, however, cause only minor injury to the leaf except for reduction of photosynthetic area.

Swelling on the lower surface of the leaf, opposite the spermogonia may be observed approximately ten days after the spermogonia cease exudation (see Table I). Sections of the lesions reveal that this swelling is due to both hypertrophy and hyperplasia of the mesophyll tissue, resulting in long palisade-like cells closely packed together. Hypertrophy of the leaf is confined to the area occupied by the lesion and may increase the thickness of the leaf to more than five times normal (Plate 168, Fig. 1). It is not until this stage in the development of the rust that severe leaf killing can be caused by relatively few lesions per leaf; this is especially true of vein infections (MacLachlan, 1935a).

Following the time during which hypertrophy of the lesion takes place, minute swellings may be seen on the lower surface, rarely on the upper surface, which, within two or three days time, break through the epidermis and appear as greyish acuminate cylinders about one millimeter in diameter. These are the peridia of the developing aecia and are first evident approximately ninety-six days after inoculation (see Table I). The peridia are not arranged in any definite pattern except when they occur on veins or petioles; in that case they may be arranged in two rows, one on each side of the vein or petiole (Plate 167, Fig. 4); they may develop to a length of more than six millimeters and may vary in number from one to more than fifty per lesion. Within each peridium are the aeciospores which are released by the splitting and shredding of the peridium a short distance from the distal end (Plate 171, Fig. 2). Unlike *G. Juniperi-virginianae* the peridial cells do not recurve with changes in humidity to release the aeciospores; the latter are shed through the shredded region of the peridium. High winds as well as the effect of one leaf rubbing on another have a marked influence in breaking up the peridium to release the aeciospores.

The peridial cells, as described by Kern (1911), are "broadly lanceolate in face view, 15–23 $\times$ 60–90 μ, linear-rhomboid in side view, 13–19 μ thick, outer wall about 1.5 μ thick, smooth, inner and side walls 3–5 μ thick, rather densely rugose with ridge-like papillae of varying length." As has been demonstrated by Thomas and Mills (1929b), the peridial cells are shorter and broader towards the distal end of the peridium and do not separate easily from each other.

The aeciospores are borne in chains from the base of the aecial cup and when mature are, as described by Kern (1911), "globoid or broadly ellipsoid, 15–19 $\times$ 18–25 μ, wall light chestnut brown, 1.5–2 μ thick, finely verrucose." In Plate 173, Fig. 2 may be seen a photograph of

aeciospores at the same magnification as the spermatia in Fig. 1. Two of the aeciospores (lighter color in the figure) were colorless; these colorless spores were found occasionally and proved to be viable.

Sections reveal that the aecium itself is long and narrow and deeply embedded in the hypertrophied tissue, the base of the aecium approximating that of the palisade layer of the leaf (illustrated by Weimer, 1917b). In Plate 168, Figs. 1 and 2 may be seen photographs of a longitudinal section through several aecia; the non-median sections give the appearance that the aecia begin at various levels throughout the hypertrophied tissue.

The great majority of the aeciospores are distributed by the middle of September. Remnants of the peridia may remain on the lesion until the leaves normally drop, but usually the circular pits in the aecial cups are all that can be seen at this time. Sections through the lesions after the leaves have dropped reveal very few viable aeciospores; most of those that still remain in the base of the aecium are hollow and sterile.

Insects have been observed feeding on the aeciospores during August. The peridia containing the aeciospores are eaten out first, then the insects, after gaining entrance by way of the pits into the aecial cups, proceed to break down the whole interior of the lesion.

(b) On the foliage of pomaceous hosts other than *Crataegus*.

Pyrus: The lesions on the ornamental species are smaller than those found on *Crataegus*. They vary greatly. On some host species they are very minute, being less than a millimeter in diameter and producing a few spermogonia only (e.g. *P. serrulata* Rehd.); others may exhibit two or three aecia on each lesion (e.g. *P. Balansae* Decne.); still others may exhibit lesions which are two to three millimeters in diameter with several aecia each (e.g. *P. betulaefolia* Bge.) (Plate 166, Fig. 4). On *P. betulaefolia* the red borders around the lesions are conspicuous. Stewart (1910) describes the lesions on Kieffer pear as being bright yellow and pin-head in size on June first. He states, further, that by June fifteenth the lesions had turned brown to black with conspicuous red borders on the upper surface of the leaf but without the red borders on the lower surface. He adds that a few aecia are formed on the upper side of the leaf, but most of them are on the lower side, frequently on each side of the mid-rib. Hesler and Whetzel (1917) describe the lesions as being orange-colored in June, one quarter to one half inch in diameter with red borders showing on the upper side of the leaf. In the fall the lesions turned dark on the under side of the leaf and at this time of year showed no red border.

Sorbus: The lesions in all cases were very small, rarely measuring more than one to two millimeters in diameter, with an average of three to five aecial horns per lesion (Plate I, Fig. 3). As in *Pyrus* the lesions on certain species died and turned brown shortly after the spermogonia appeared.

Malus: Inoculation on ornamental apples resulted in small lesions that rarely measured more than one to two millimeters in diameter (Plate 166, Fig. 5). Certain species exhibited spermogonia only. Crosby, Mills and Blauvelt (1929), Sherbakoff (1932) and others have reported this small type of lesion on commercial apples and refer to it as one method of distinguishing *G. Juniperi-virginianae* from *G. globosum*. Bliss (1931), by culture, obtained flecking only on nine varieties of commercial apples.

(c) On the flowers and fruit.

Infection of flowers and fruit of *Crataegus* is relatively rare when compared to the prevalence of foliar infection. All parts of the flower including pedicel, ovary, sepals, petals and even stamens may be attacked. Infections on the stamens and petals cannot persist but infections of the ovary result in either dwarfing and killing of the fruit (Plate 167, Fig. 1) or premature ripening and dropping of the fruit. Abundant spermogonia and aecia may be produced (Plate 167, Fig. 2). A cross section of a diseased fruit reveals that only a portion of the fruit is affected. In Plate 168, Fig. 3 may be seen a photograph of such a section; the diseased area is represented by the darkened strip on one side of the section. On the opposite side of the section may be seen some of the diseased area of a second lesion. As in the leaf, hypertrophied, palisade-like, densely packed host cells are evident. The fungal mycelium is intercellular and produces haustoria in the host cells. Some mycelium can be seen ramifying among the host tissue beyond the hypertrophied area.

Fruit infection of *Pyrus* was not observed in the Arnold Arboretum. Stewart (1910) reports the Kieffer pear as suffering infection from this rust at Long Island, New York. In particular he finds the diseased fruits are very small and misshapen, usually exhibiting circular black areas devoid of aecia, although a few show aecia. Hesler and Whetzel (1917) report somewhat similar symptoms on the fruit of pear.

Fruit infection of *Malus* has not been observed by the writer. Garman (1899), speaking collectively of *G. Juniperi-virginianae* and *G. globosum*, reported these rusts on the fruit of *Malus;* he found the infection to be most abundant on crab apples.

(d) On the twigs.

Infection of the twigs of *Crataegus* is relatively rare and occurs on the current year's growth only. Both spermogonia and aecia may be produced (Plate 167, Fig. 5). Similar infections of the thorns and axillary buds have also been observed (Plate 167, Fig. 3). A cross section of a diseased twig reveals that the infection is confined to the cortical region (Plate 168, Fig. 4). The same typical, densely packed, hypertrophied cells that occur in the leaves and fruit may be seen in the diseased area. The aecial cups, however, appear shorter and broader than those exhibited in diseased leaves. Several diseased twigs were tagged in the fall of 1932 to determine if the mycelium might be perennial in the twigs; such was not evident as the twigs were all dead the following spring.

B. On Juniperus Hosts

The advanced stage of the disease caused by *G. globosum* on the *Juniperus* host is expressed in the form of a woody gall attached firmly to a twig that may be more than two or three years old. This condition led early observers to conclude that infection originated in the stem. Farlow (1880) who named this fungus stated that the disease is first manifested by bursting through the stem at the point of attachment of the leaves. Kern (1911) described the gall as being caulicolous. Stewart (1915) gave an elaborate account of histological studies made, which he interpreted as showing that the gall originates from the axils of leaves and are evidently transformed axillary buds. Weimer (1917a), after examining Stewart's slides, showed that Stewart mistook an axillary bud for a gall. He (Weimer, 1917a) gave a full description of a normal juniper leaf and presented definite proof that the gall may originate in the leaf. Bliss (1933) has substantiated the results of Weimer and has illustrated stages in the progressive development of the gall on the leaf. Several brief descriptions of the mature gall as it occurs on the red cedar may be found in the literature; these descriptions are given, for the most part, as an aid in distinguishing the galls caused by *G. globosum* from those caused by *G. Juniperi-virginianae*.

To obtain a more complete picture of the progressive development of the various symptoms and signs of the disease caused by *G. globosum* on the red cedar, the writer has carried on further studies both morphologically and histologically. Material for study was obtained from a locus of infection that was isolated from other *Gymnosporangium* rusts. The symptoms and signs will be considered as they occur on the red cedar in eastern Massachusetts.

The initial manifestations of the disease caused by this rust may be found on one year old leaves of infected red cedars about the first of August. The exhibition of a yellowish chlorotic zone or band on the leaf is closely followed by the formation of a slightly raised area on the inner (upper) surface of the leaf; the lifting of the epidermis over the point of infection is due to the development of a very young gall underneath.

Longitudinal splits in the epidermis immediately over the raised area allow the young gall to emerge. On long subulate leaves the gall may occur at any place throughout the length of the leaf; in Plate 169, Figs. 2 and 3, may be seen young galls developing near the tip, in the middle and near the base of the leaf. The usual type of leaf and young gall that is found is illustrated in Plate 169, Fig. 1; the leaves are short and the gall must of necessity be brought in close contact with the stem, a phenomenon which led early investigators to conclude that the gall originates in the stem at the base of the leaf.

A longitudinal section of a portion of a twig bearing two normal leaves as well as a diseased leaf, at approximately the same stage of gall development that is shown in Plate 169, Fig. 1, is illustrated in Plate 170, Fig. 1. A comparison of the two normal leaves with the diseased leaf reveals marked hypertrophy and hyperplasia of the mesophyll of the latter. Distortion of the vascular system may also be seen. Figs. 4 and 5 of Plate 170 exemplify further the distortion of the vascular elements. In Fig. 4 parenchymatous cells may be seen separating the vascular elements. In Figs. 2 and 3 a corky layer, several cells thick and completely surrounding the portion of the gall not in contact with the twig, may be seen. This corky layer usually cuts off the tip of the leaf; it is of interest to note in Figs. 3 and 4 the sharp severing of the vascular strand. The tip of the leaf that is cut off together with the mycelium of the rust that may be found in it dies; remnants of this dead portion may be found on the gall for two or three years afterwards. Intercellular mycelium is abundant throughout the gall tissue but haustoria were not observed at this stage.

The gall as seen in late autumn and winter is smooth, shiny and mahogany red in color, rarely exceeding a diameter of half a centimeter. This is in striking contrast to the larger, greenish and more or less convoluted gall of *G. Juniperi-virginianae*.

About the last of March of the following spring light orange colored markings may be seen over the surface of the gall. These markings represent early stages in the rupturing of the corky epidermis and are caused by the underlying masses of hyphae—the telia primordia—from

which the teliospores arise. Progressive stages in the maturation of the teliospores from this dense hyphal layer are shown in Plate 171, Figs. 5, 6 and 7. Dodge (1918) has published an extensive cytological study of the development of the teliospores and has illustrated progressive stages of their maturation. The teliospores mature progressively from the centre towards the periphery of the layer of telia primordia. The corky epidermis is ruptured over the maturing teliospores and the latter emerge as a cinnamon-brown, pulvinate mass (Plate 171, Fig. 4). The irregular outline of this rupture readily distinguishes the galls caused by this rust from those caused by *G. Juniperi-virginianae* since the telial sori of the latter emerge through circular openings. The teliospores are borne on pedicels and the extension of these pedicels, as the teliospores progressively mature from the centre towards the periphery of the basal layer of mycelium, enlarges the sorus to form a tongue or wedge-shaped structure, the centre of which may be hollow. This cavity is due to the developing teliospores around the peripheral regions of the sorus; these push up the mature teliospores in the centre and as a result the pedicels of the latter teliospores are broken off.

A mature telial sorus, if kept dry, is a tongue-like or wedge-shaped flange 1–3 mm. broad by 2–5 mm. long at the base and 6–12 mm. high. A section through such a sorus reveals a dense cinnamon-brown layer of teliospores, several spores thick, over the surface. Under the spore layer is a dense white mass composed entirely of long pedicels, one for each teliospore. The peripheral pedicels still remain attached to the layer of mycelium from which they arose; while the pedicels in the central region, which have been broken off from the layer of mycelium from which they arose, are suspended to form a conical amphitheatre-like cavity in the centre.

The teliospores are typically two-celled and are, as described by Kern (1911), "ellipsoid, 16–21 × 37–48 μ somewhat narrowed above and below, slightly constricted at the septum, wall pale cinnamon-brown, 1–2 μ thick; pores 2 in each cell, near the septum." Pammel (1905) has described one-celled teliospores. No single-celled teliospores have been observed by the writer; three- and four-celled teliospores, however, as well as four-celled teliospores with one cell abortive have been found (Plate 173, Fig. 3).

Studies with respect to the nature of the pedicels of the teliospores and the effect of wetting will be considered later (page 16).

Wetting of the telial sori by rains in May causes them to expand to many times their original size. Progressive stages in the expansion of sori on galls as well as on the small infections that take place on the long

subulate leaves are illustrated in Plate 172. The hygroscopical nature of the pedicels (see page 16) is responsible for this expansion. If only a portion of the teliospores are mature at the time of wetting, the telial mass may, on drying, shrink to somewhat of its original shape and size. If, however, all the teliospores are mature at the time of original wetting and the humidity remains high for a sufficient length of time to fully expand the telial mass, the latter, on drying, will shrink to an amorphous sheet or strand and later fall away from the gall. Under favorable weather conditions practically all the teliospores are mature within three to five weeks from the time of their initial appearance.

Germination of the teliospores results in the production of basidiospores. Progressive stages in the production of the latter are shown in Plate 174, Fig. 1. The basidiospores may be seen as a powdery, somewhat velvety coating over the surface of the expanded telial sorus and are evident about five or six hours after the expansion takes place. These basidiospores will drop from the gall of their own accord but are usually carried away by the air currents. The basidiospores are ovate, flattened on one side, slightly tapering towards the end of attachment to the sterigmata; thin-walled (less than 1 μ thick); protoplasm light orange-yellow in color containing numerous oil droplets which tend to aggregate (Plate 173, Fig. 4); size, 12–16 (average, 13.7 μ) × 7–11 (average, 8.9 μ). Under favorable conditions they germinate immediately after their formation to form relatively long germ tubes (Plate 174, Fig. 4). If the spores are allowed to dry shortly after the germ tubes begin to develop, small secondary spores may be formed (Fig. 5).

As a rule, the majority of the teliospores have germinated by May 25. The dried up remnants of pedicels and empty teliospores blow away leaving a smooth orange colored scar bordered by the lacerated edges of the broken corky epidermis. This scar soon turns greyish brown and may persist on the gall surface during the remainder of the life of the gall (Plate 171, Fig. 4). Cross sections through the gall reveal that the tissue immediately underlying this scar dies and a corky layer develops, segregating this dead area from the remaining living tissue of the gall (Plate 170, Fig. 5).

The gall continues growth during the summer causing distortion of the neighboring twigs (Plate 169, Fig. 5) and in some cases killing of the twig beyond the gall (Plate 169, Figs. 4 and 6). The original single vascular strand of the leaf now shows as a many-branched structure (Plate 170, Fig. 5). New growth beyond the gall as well as the natural dropping of the older leaves and the formation of a corky epidermis on the twig surrounding the gall give the appearance that the gall originated

in the stem rather than in the leaf. This illusion is further substantiated by the tendency of the gall to become woody in appearance as it grows older (Plate 169, Fig. 7).

The gall is commonly referred to as being perennial in nature. For how many years it will live and produce teliospores is not known; in Plate 169, Fig. 7 is shown a gall that produced teliospores for three consecutive years. The telial sori are formed each year between the scars where teliospores were produced the previous years (Plate 171, Fig. 4). It is doubtful that many of the galls persist for more than three or four years, because, by that time the surface of a gall would be completely covered with dead tissue resulting from the formation of the telial sori. Long subulate leaves on which infection takes place usually drop after the first crop of spores; these infections, then, can persist for one year only.

V. FACTORS AFFECTING SPORE GERMINATION

A. The Time Factor

The teliospores exhibit a low and inconsistent percentage of germination when tested immediately after their appearance on the gall. If twigs bearing galls on which teliospores are just emerging are placed in water in the greenhouse, abundant germination can be obtained, regularly, in a week to ten days time. The maturation period of the teliospores is longer, depending on the weather conditions, when the galls bearing them are left in the field. Normally, the teliospores will all have germinated within six to eight weeks after their formation. Under low temperature conditions, however, they have the potential ability to remain viable for a much longer time; in Plate 175, Fig. 3 may be seen severe infection obtained on leaves of *Crataegus Jonesae* Sarg. using, as inoculum, teliospores that had been kept in the refrigerator for one year.

The basidiospores have the ability to germinate immediately after their formation. The length of time that they will live is still a question; basidiospores of *G. Juniperi-virginianae* will live for many days above a humidity of 25% and below a temperature of 25° C. (MacLachlan, 1935b).

Aeciospores will not germinate to the extent of more than 2 or 3% at the time of their formation. Nevertheless, if hawthorn leaves bearing aecia are collected in August before the aeciospores are shed and placed in a refrigerator at 0° C., abundant germination can be obtained within a month's time and by the first week in October more than 80% germination can be obtained consistently. By keeping the infected leaves at this temperature, the same high degree of germination can be

obtained until the first of March of the following year; after this date, however, the percentage of germination that can be obtained falls off rapidly. Whether the infected leaves are kept in a dry container or a moist chamber makes no difference in the percentage germination obtained. It may be noted that on one occasion more than 75% germination was obtained in August, 1932, using aeciospores taken from unbroken peridia of an infected leaf of *Crataegus shirleyensis* Sarg.

B. The Humidity Factor

Tests in the laboratory revealed that none of the three spore forms would germinate, even in saturated humidity (spores placed on cover glasses over water), unless in direct contact with a drop of water. Excess water, however, causes irregularity in the percentage germination; basidiospores, especially, show a very low percentage of germination when immersed in large drops of water; under the same conditions aeciospores are not consistent in the percentage of germination that may take place; teliospores germinate in excess water but instead of producing basidiospores the promycelia grow to great lengths, presumably to come in contact with the air, and may exhibit long side tubes (Plate 174, Fig. 3), or break up to form elongated spore-like bodies (Plate 174, Fig. 2). Farlow (1880) reported a type of spore, similar to that shown in Fig. 2, which he observed when the telial masses were quickly dried after moistening. He also found that, on remoistening, these spore-like bodies would send out germ-tubes similar to those of normal basidiospores.

In the laboratory, optimum humidity conditions for germination of any of the three spore forms was obtained by placing the spores on a cover glass and inverting the latter on a Van Tieghem cell in a petri-plate lined with wet filter paper; enough water of condensation would accumulate on the lower (spore) surface of the cover glass to give optimum humidity conditions for germination. In the field, very satisfactory humidity conditions for infecting the pomaceous host were obtained by painting the leaves with an aqueous suspension of the teliospores and enclosing the inoculated twig in a celluloid cylinder, the ends of which were plugged with moist sphagnum.

C. The Temperature Factor

Temperature has a marked effect on the percentage of germination that may be obtained. Miller (1932) found 24° C. to be the optimum temperature for the germination of teliospores and aeciospores, and 16° C. the optimum for basidiospores. In Table II may be found data

TABLE II

DATA ON THE PERCENTAGE GERMINATION OF THE SPORES OF G. GLOBOSUM[1] WHEN SUBJECTED TO DIFFERENT TEMPERATURES[1]

Temp. °C.	Percentage germination of teliospores	basidiospores	aeciospores
2	0.0	—	0.0
5	0.3	0.0	5.2
7	0.7	7.2	8.2
10	80.4	68.7	11.3
15	90.9	79.2	70.2
20	96.3	83.9	88.7
25	98.6	63.1	60.7
30	59.8	14.5	35.3
35	0.9	0.9	0.6
38	0.0	0.0	0.0

on the percentage germination of the three spore forms when subjected to various temperatures; these data have been plotted in Fig. 2. Examination of Fig. 2 reveals that: (1) the teliospores have a very wide range of temperature within which more than 80% germination may take place, (2) the corresponding curve for basidiospore germination has the same general contour, except at a lower level, (3) the aeciospores have a narrower range of temperature within which a high percentage of germination may take place, the optimum being around 20° C., (4) below a temperature of 10° C. and above a temperature of 30° C. the percentage germination of all three spore forms drops off to almost zero.

VI. THE NATURE OF THE TELIAL SORUS

Reference was made under SYMPTOMATOLOGY (page 12) to the marked expansion of the telial excrescences on the galls during wet weather. In Plate 172 may be seen photographs of progressive stages in the expansion of these telia. Further studies were made with respect to this phenomenon.

It was found that the pedicels of the teliospores, when wetted, are responsible for this expansion process. No estimation has been made with respect to the number of teliospores and the corresponding number of pedicels that may exist in a single telium, yet, they must number in the millions. Crowell (1934) has given estimations which indicate that four to five million teliospores may exist in a telium of *G. Juniperi-*

[1]1500 spores were counted in each sample. Counts were made 24 hours after the cultures were set up.

virginianae; the number that may exist in a telium of *G. globosum* would be as many or more as the telia are characteristically larger in the latter rust. The pedicels, as well as being numerous, are relatively long; some idea of their length may be obtained in Plate 175, Fig. 5. Under strong light and on a dark background they appear white and opaque; they do not stain readily in aqueous methylene blue. In Plate 175, Fig. 4 may be seen a photograph of a pedicel that was immersed in 25% alcoholic

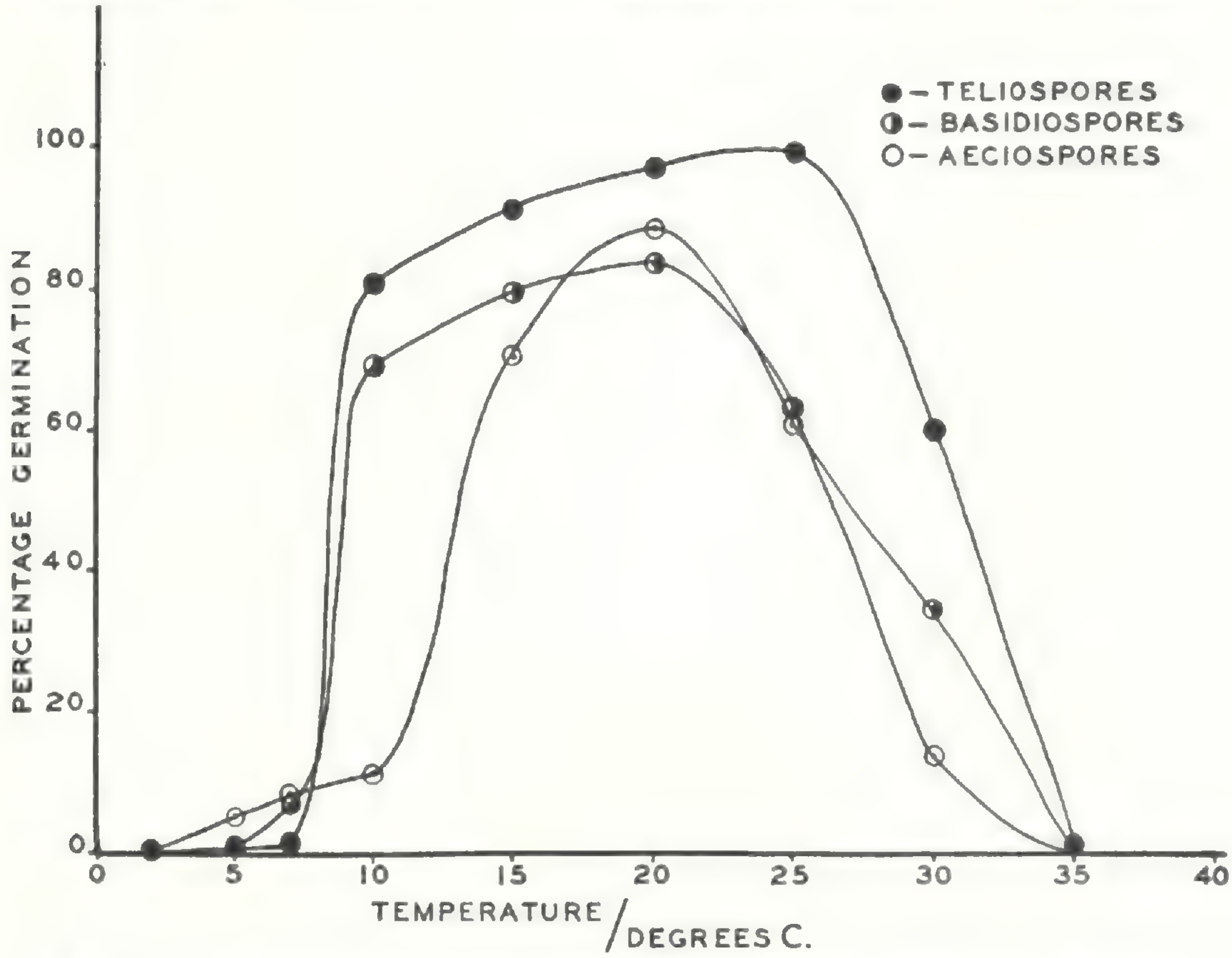

FIG. 2. THE INFLUENCE OF TEMPERATURE ON THE PERCENTAGE GERMINATION THAT MAY BE OBTAINED FOR THE THREE SPORE FORMS.

methylene blue for fifteen hours; the pedicel itself did not stain to any extent but the stain was absorbed in the centre of the pedicel indicating the presence of a lumen. The hygroscopic nature of the pedicel is illustrated in Plate 175, Figs. 1 and 2. The pedicels represented in Fig. 1 were subjected to 95% alcohol for twelve hours while those represented in Fig. 2 were placed in water for the same length of time. The two pictures are at different magnifications but when one compares the diameter of the pedicel with the size of the teliospore which it subtends, it is quite evident that the pedicels are capable of considerable expansion when wet; Fig. 1 illustrates the pedicel as it would appear when the telium is dry while Fig. 2 illustrates the pedicel as it would appear during

rainy weather in May. In Fig. 2 may also be seen small air bubbles existing in the region that was once the lumen but is now filled by the expanded wall of the pedicel. On the other hand, as may be seen in Fig. 1, the lumen is relatively wide with respect to the diameter of the desiccated pedicel. Taking into consideration, then, the number of pedicels present in a telium as well as their length and the diameter they may attain when wet, one can readily see how a telium may expand to the size that is so common on infected cedars during rainy periods in May.

VII. INFECTION OF THE RED CEDAR

A. Time of Infection

The actual time of year that infection of the red cedar by the aeciospores takes place is still conjectural. About 2% of the aeciospores will germinate at the time of their dispersal in late August and when one realizes the large number of aeciospores that may be released from infected pomaceous hosts it can be presumed that possibly some infection may take place immediately. Nevertheless, the fact that more than 80% germination can be obtained after the fresh aeciospores have been subjected to 0° C. for about six weeks time (cf. page 14) would indicate that both time and low temperature are involved in the maturation of the aeciospore. This would indicate that infection takes place in late fall after frosts have occurred. The fact that a high percentage of germination can be obtained in March of the following spring, using aeciospores that have been kept at 0° C. during the interim, would not necessarily mean that infection takes place in the spring; if the aeciospores are mature in late fall, in all probability they will have all germinated long before March.

B. Infection Process

Having access to an abundance of aeciospores which would germinate readily, attempts were made to trace the method by which infection of the red cedar by this rust takes place.

Leaves of the current year's growth were removed from potted red cedars, washed carefully and dusted on the stomatal (inner and upper) surface with aeciospores. The inoculated leaves were then inverted and placed on moist filter-paper in petri-plates. Examination 24 hours later revealed abundant germination of the aeciospores; the germ tubes were long and slender and sometimes spiralled; the protoplasm had all migrated to the end of the germ tubes. Within 12 hours more, the ends of the germ tubes had enlarged to form irregular and sometimes convoluted

haustoria-like formations. On one occasion the germ tube was observed to bend at a sharp right angle to form the haustoria-like structure over a stoma; however, no consistent orientation of the germ tubes with respect to the location of stomata could be observed. The haustoria-like structures that happened to form over stomata were smaller than those that formed on the inter-stomatal regions of the leaf epidermis. Two samples of about fifty leaves each were removed from the culture and killed for embedding thirty-six and fifty-two hours, respectively, from the time of inoculation. These were sectioned (both transversely and longitudinally), stained with safranin and light green and examined under the high power of the microscope in hopes of observing the method of penetration.

The length of the germ tubes made it impossible to obtain even a series of sections that showed an aeciospore connected to its germ tube throughout its entire length. This led to a difficulty in the identification of germ tubes that were observed entering the leaf and consequently the results obtained can only be considered as indications and not conclusive proof. The characteristic intercellular mycelium of *G. globosum* was found around the mesophyll cells in the immediate vicinity of the stomata. Hyphae of the same diameter as the germ tubes were found passing through the stomata; in some instances three or four passed through the same stoma. Some of the haustoria-like structures were found to be still clinging to the surface of the leaf but no penetration from them was observed.

Whether the germ tubes that were observed passing through the stomata were those of *G. globosum* or of some other fungus that happened to be mixed with the aeciospores cannot be said for certain. It is quite safe to say, however, that the rust gains entrance through the upper epidermis of the leaf on which the stomata exist, as the characteristic intercellular hyphae of this rust were found around the mesophyll cells immediately under the stomata. Further studies on this problem will be carried out by the writer.

VIII. SUMMARY

At least thirteen names have been given to the rust now known as *Gymnosporangium globosum* Farl. Of these the authentic names for the III and O & I stages of the rust stand as *Gymnosporangium globosum* Farl. and *Roestelia globosa* Shear, respectively. The name *Gymnosporangium globosum* Farl. is now accepted as referring to either stages of the rust.

Gymnosporangium globosum is confined in its range to the eastern and central parts of the United States and to the southern parts of Ontario and Quebec. The rust is increasing in prevalence and in localized areas is causing great damage to both the ornamental and orchard trees; this is especially true in eastern New York State.

The diseases caused by *G. globosum* occur on at least ten genera of the Pomoideae and on at least three species of *Juniperus*. The symptoms and signs of the diseases caused by this rust may be found on the foliage and to a lesser extent on the flowers, fruit and twigs of the pomaceous hosts and on the foliage and twigs of the Juniperus hosts. The progressive development of these symptoms and signs as they occur on the aforementioned organs of the respective hosts have been described and illustrated.

The factors of time, humidity and temperature have been considered with respect to the percentage germination of the teliospores, basidiospores and aeciospores that may be obtained. The age of the three spore forms as well as the temperature to which they are subjected have a marked effect on the percentage germination that can be obtained. The amount of water present also modifies the percentage germination that can be obtained as well as the type of germ tubes that may be exhibited.

All evidences indicate that infection of the red cedar by *G. globosum* occurs, primarily, in late autumn. From studies of the infection process it would appear that infection of this host takes place through the upper and stomatal surfaces of the leaves.

IX. ACKNOWLEDGMENTS

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XI. EXPLANATION OF PLATES

PLATE 166

Aecial stage of *G. globosum* on the foliage of pomaceous hosts. Unless signified inoculations were artificial.

Fig. 1. On *Crataegomespilus grandiflora* Bean. Note leaf killing.
Fig. 2. On *Crataegus prunifolia* (Marsh.) Persoon.
Fig. 3. On *Sorbus americana* Marsh. The lesions are very small.
Fig. 4. On *Pyrus betulaefolia* Bge.
Fig. 5. On *Malus* sp. (Natural infection.)

PLATE 167

Aecial stage of *G. globosum* on various parts of Crataegus hosts. (Artificial inoculations.)

Fig. 1. Dwarfing and killing of fruit.
Fig. 2. Abundant aecia produced on basal portion of a fruit.
Fig. 3. On a terminal bud that was forming in the axil of a leaf.
Fig. 4. On the petiole of a leaf.
Fig. 5. On twigs of the current year's growth.

PLATE 168

Histological sections of *Crataegus* showing diseased areas.

Fig. 1. Cross section through a diseased Crataegus leaf showing the amount of hypertrophy that may occur in the lesion. Longitudinal sections through various portions of aecia may be seen also.
Fig. 2. An enlarged portion of a lesion similar to that shown in Fig. 1. Hypertrophy of the mesophyll has resulted in palisade-like, densely packed, cells in which the chloroplasts have disappeared. The section also shows a near-median section of an aecium.
Fig. 3. Section through a diseased Crataegus fruit. Hypertrophied area of the lesion shows as a dark strip in the photograph. This area is composed of densely packed, palisade-like, cells similar to those which occur in the foliar lesions.

Fig. 4. Cross section through a lesion on a Crataegus twig. Hypertrophy and intercellular mycelium are confined to cortical regions. The aecial cups are characteristically shorter and broader than those found on the foliage.
Fig. 5. Intercellular mycelium in the mesophyll of a diseased Crataegus leaf under a spermogonium before hypertrophy has set in.

PLATE 169

Galls of *G. globosum* in various stages on leaves and twigs of Juniperus host (Red-cedar).

Fig. 1. The usual type of young galls that may be seen breaking through the upper surfaces of leaves about September 1st.
Figs. 2 and 3. Young galls at a similar stage of development that is shown in Fig. 1, in long subulate leaves.
Fig. 4. A one-year-old gall that has caused the death of the twig beyond it.
Fig. 5. A two-year-old gall that is causing distortion of the twigs.
Fig. 6. A two-year-old gall that has killed the twig beyond the point of infection. The dead portion of the twig has fallen away. (See Fig. 4.)
Fig. 7. An old gall (3 or 4 years) that gives the appearance of having originated in the stem. The infection that resulted in this gall took place when the twig bearing it was young and covered with green leaves.

PLATE 170

Histological sections of *Juniperus* infected with *G. globosum.*

Fig. 1. Longitudinal section through a twig bearing two normal leaves and an infected leaf. Note hypertrophy of the infected leaf as well as the distortion of the single strand of vascular elements.
Fig. 2. A later stage than that shown in Fig. 1. A corky layer several cells thick has set in that surrounds the gall and cuts off the tip of the leaf. The tip of the leaf that is cut off together with the rust mycelium that may be found in it dies but may persist in the gall for two or three years.
Fig. 3. Enlarged portion of gall similar to that shown in Fig. 2. Note sharp severing of the vascular strand by the corky layer.
Fig. 4. Enlarged portion of section shown in Fig. 3. Note parenchyma-like cells that are forming within the vascular strand splitting up the latter.
Fig. 5. A section through a two-year-old gall. The splitting up of the single vascular strand of the original leaf has now resulted in a many-branched structure. On the upper side may be seen the dead portion on which a telial sorus was produced the previous spring; a corky layer had set in, segregating the dead portion from the remainder of the gall.

PLATE 171

Fruiting structure of *G. globosum* on *Crataegus* (Figs. 1 and 2) and *Juniperus* (Figs. 3–7).

Fig. 1. Spermogonia in the center of a foliar lesion; they have turned black and are quite conspicuous on the yellow background of the lesion.
Fig. 2. Typical aecia on the foliage. Note method of shredding of the peridial cells for the release of the aeciospores.

Fig. 3. Telial sori breaking through a young gall for the first time.
Fig. 4. Telial sori breaking through the epidermis of the gall shown in Plate 169, Fig. 7. The irregular method by which the sori rupture the epidermis readily distinguishes the galls caused by *G. globosum* from those caused by *G. Juniperi-virginianae* in which circular pit-like openings are formed. Note also the scars between the sori; within the area occupied by these scars telial sori occurred in previous years.
Figs. 5, 6 and 7. Progressive stages in the development of the layer of telia primordia that form under the corky epidermis of a gall in March. The corky layer is ruptured about the time that the teliospores are formed.

PLATE 172

Gelatinization of the telial excrescences.

Figs. 1 and 2. Before and after wetting of two infections on a long subulate leaf. No gall formation was evident on this diseased leaf.
Figs. 3, 4 and 5. Progressive stages in gelatinization of three telial sori on a single one-year-old gall.
Figs. 6 and 7. Before and after wetting of a single infection on a long subulate leaf. Note the formation of a gall on this leaf.
Fig. 8. Gelatinization of the usual type of gall that is found.

PLATE 173

Spore forms of *G. globosum* (Magnification × 545).

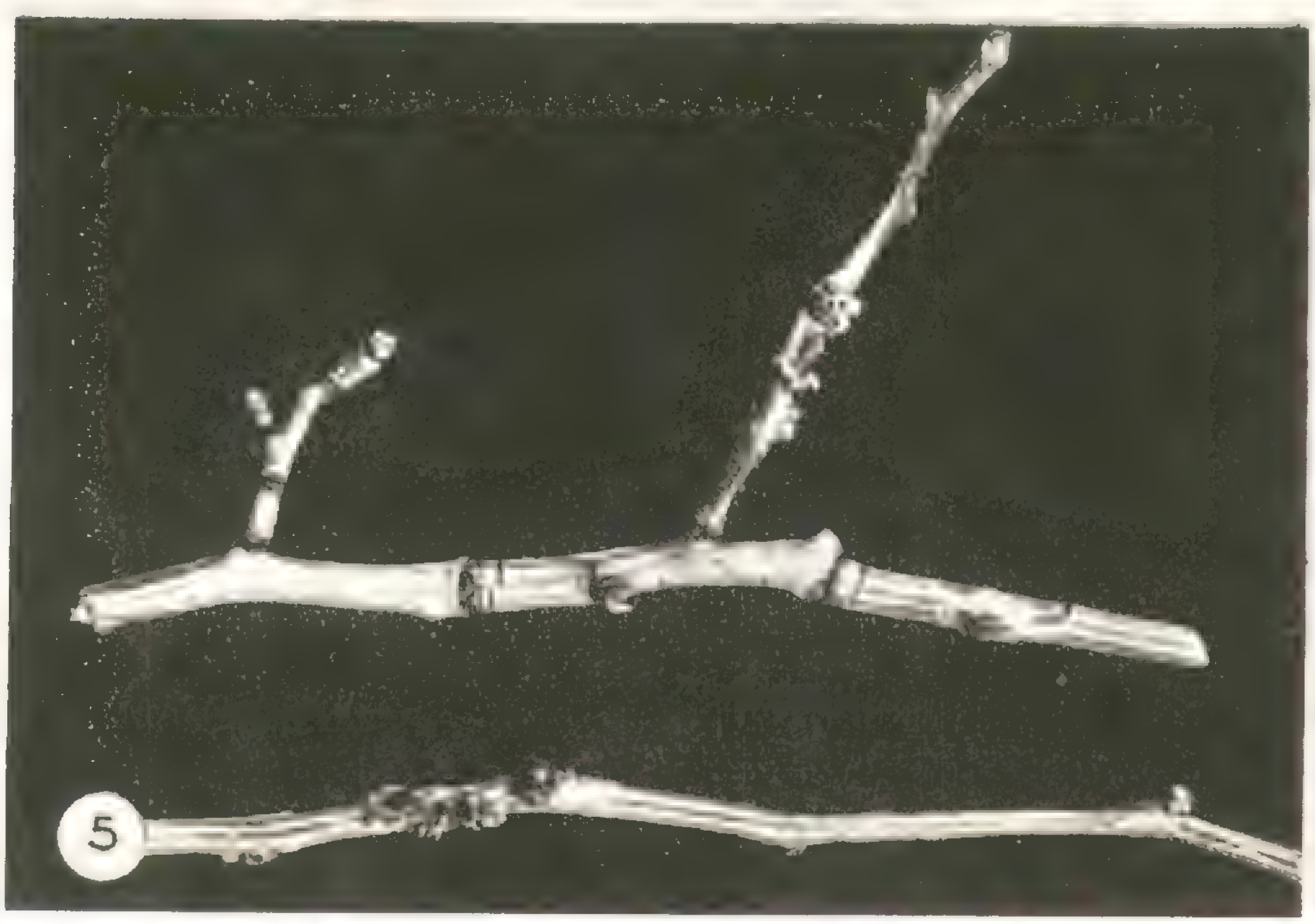
Fig. 1. Spermatia.
Fig. 2. Aeciospores. Two of the aeciospores shown in this picture were colorless; these spores proved to be viable.
Fig. 3. Teliospores. The usual type are two-celled. Occasionally three- and four-celled spores may be found. Note the four-celled teliospore with one cell abortive.
Fig. 4. Basidiospores. Note the conspicuous yellow oil droplets.

PLATE 174

Germinating spores of *G. globosum*.

Fig. 1. Progressive stages in the germination of a teliospore to the formation of basidiospores. (A portion of the promycelium of the upper cell was out of focus and does not show in the last picture.)
Fig. 2. Two promycelia of a teliospore that have broken up to form spore-like bodies instead of the normal production of basidiospores. Farlow (1880) observed these spore-like bodies germinating. They occur frequently if the teliospore is in too much water.
Fig. 3. A promycelium of a teliospore that has produced long projections instead of basidiospores. This as well occurs frequently if the teliospore is in too much water.
Fig. 4. Germinating basidiospores.
Fig. 5. A germinated basidiospore that has produced a secondary spore. Secondary spores are frequently found when the basidiospores are allowed to dry shortly after germination begins.
Fig. 6. A germinated basidiospore that has produced a side branch.
Fig. 7. Germinating aeciospores.

GYMNOSPORANGIUM GLOBOSUM Farl.



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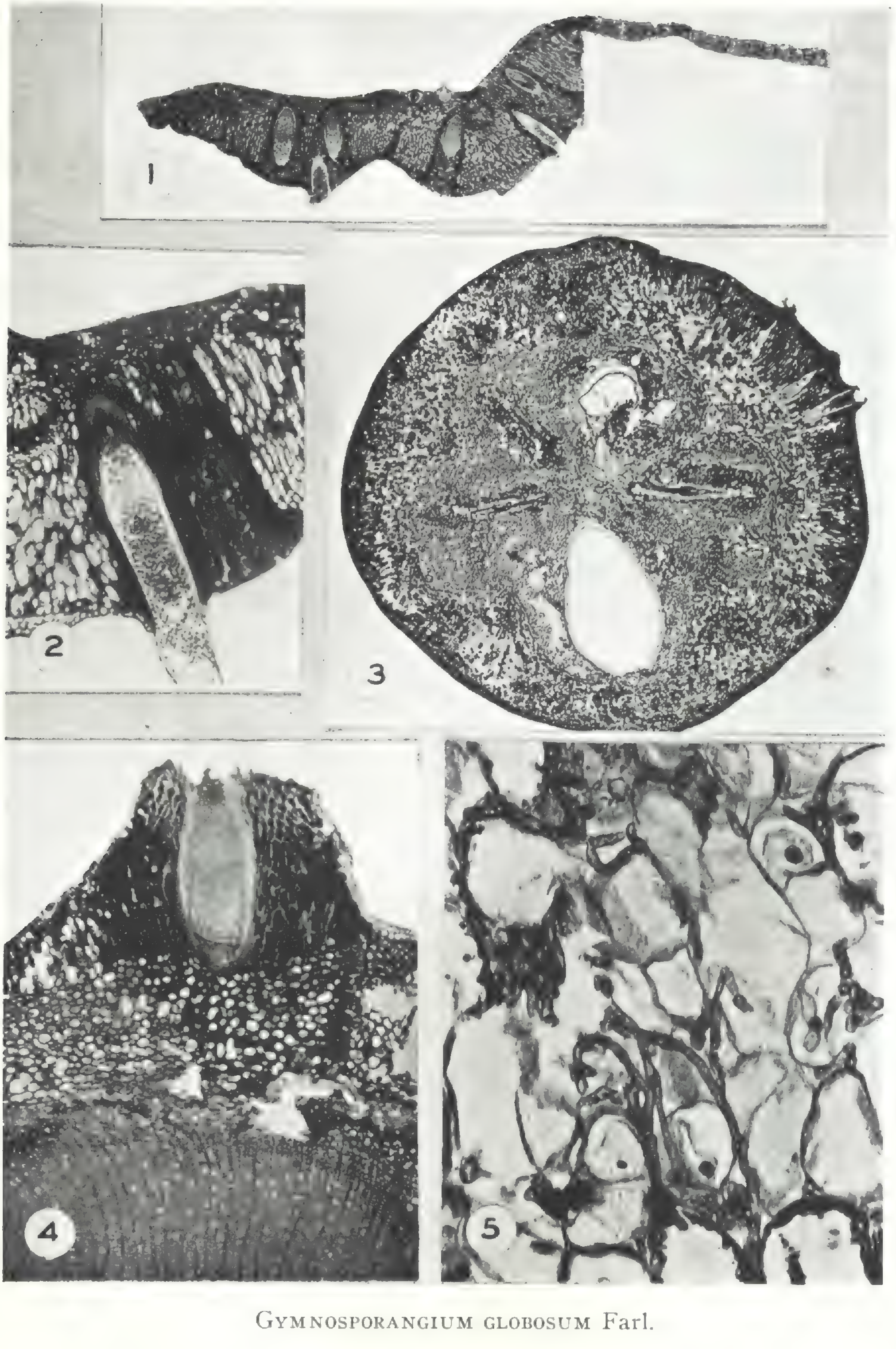

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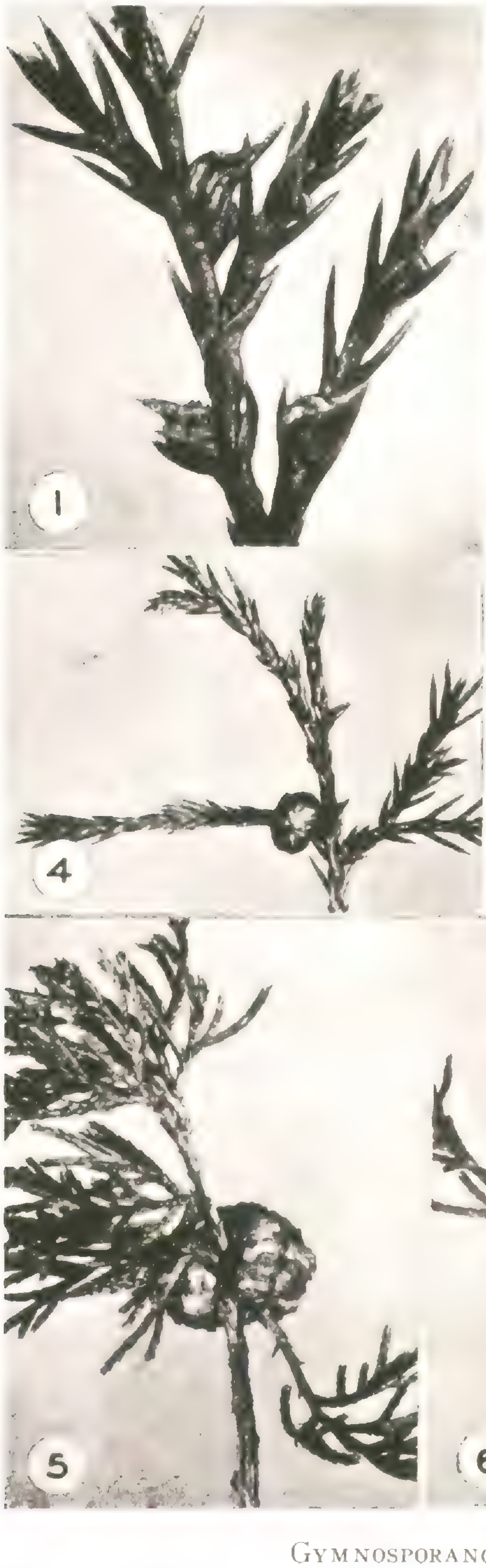

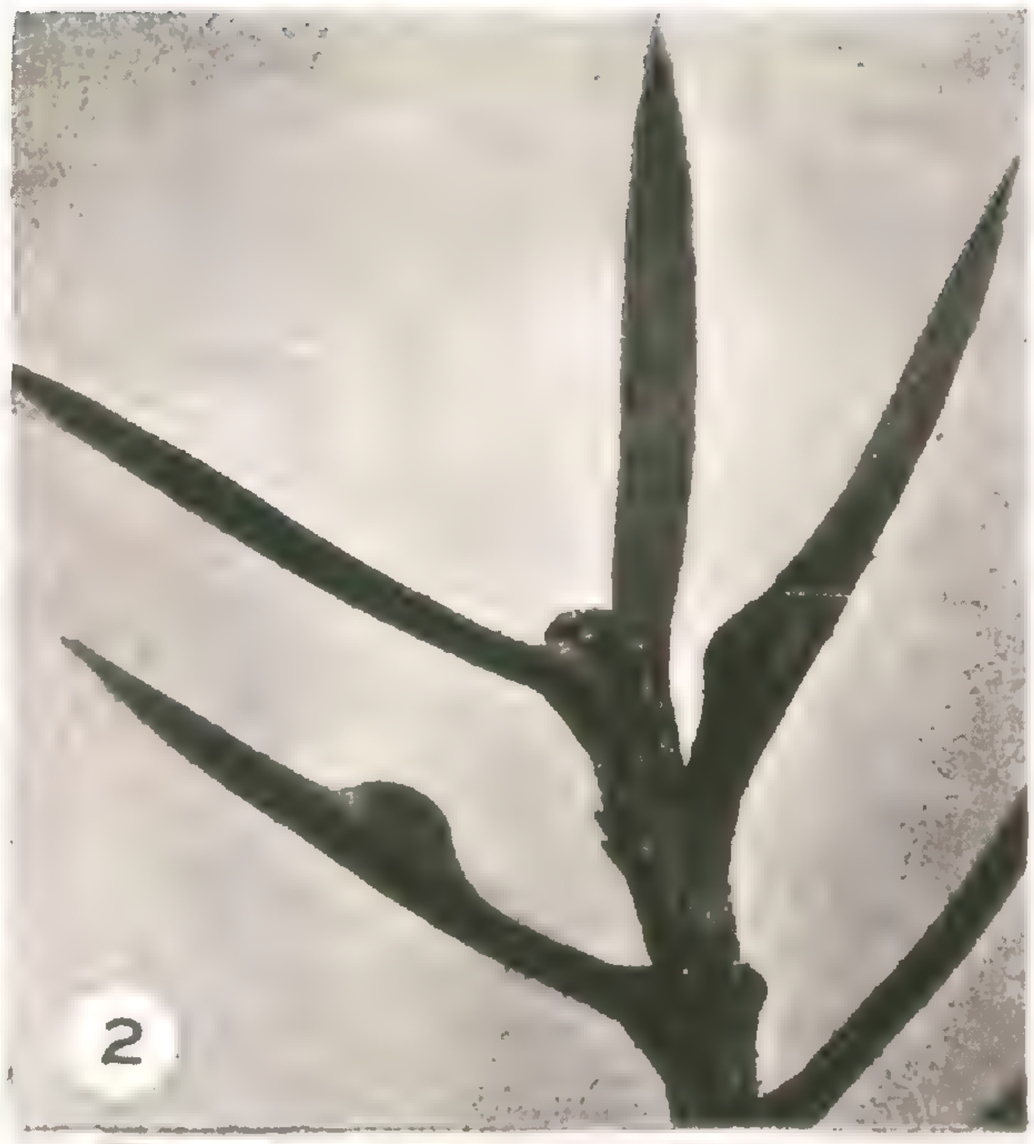

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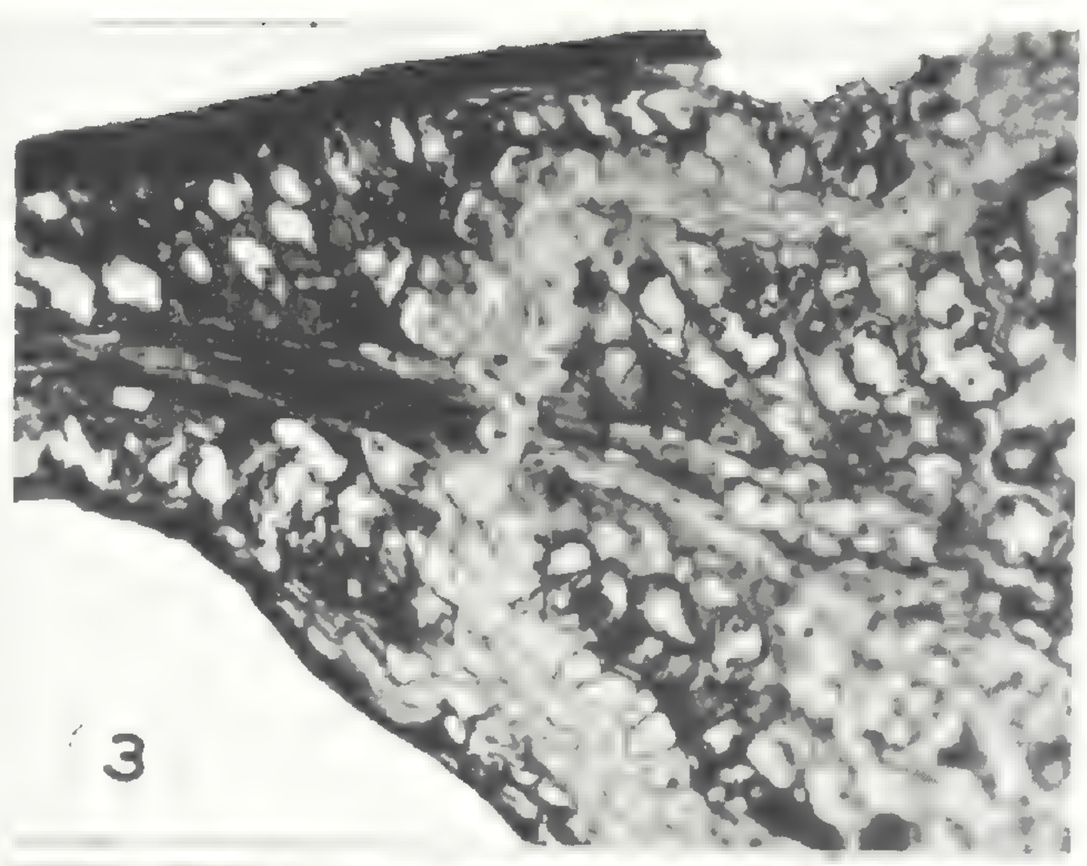

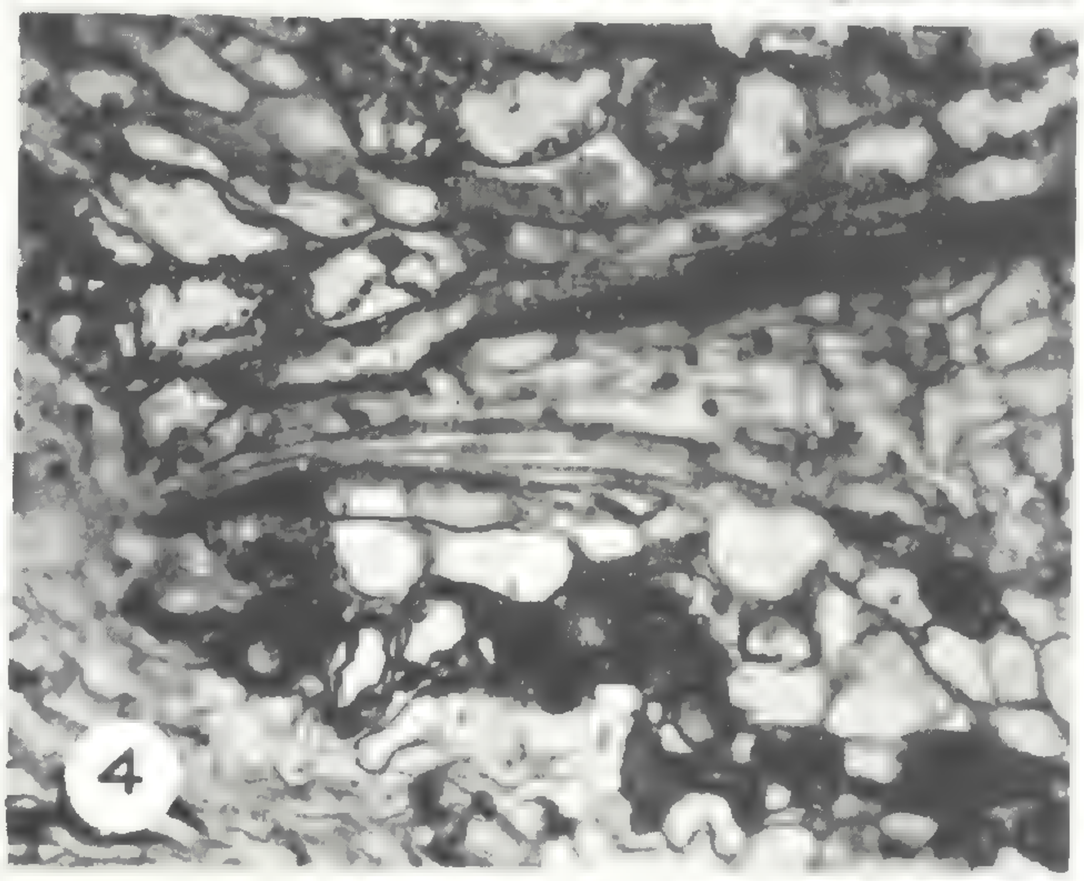

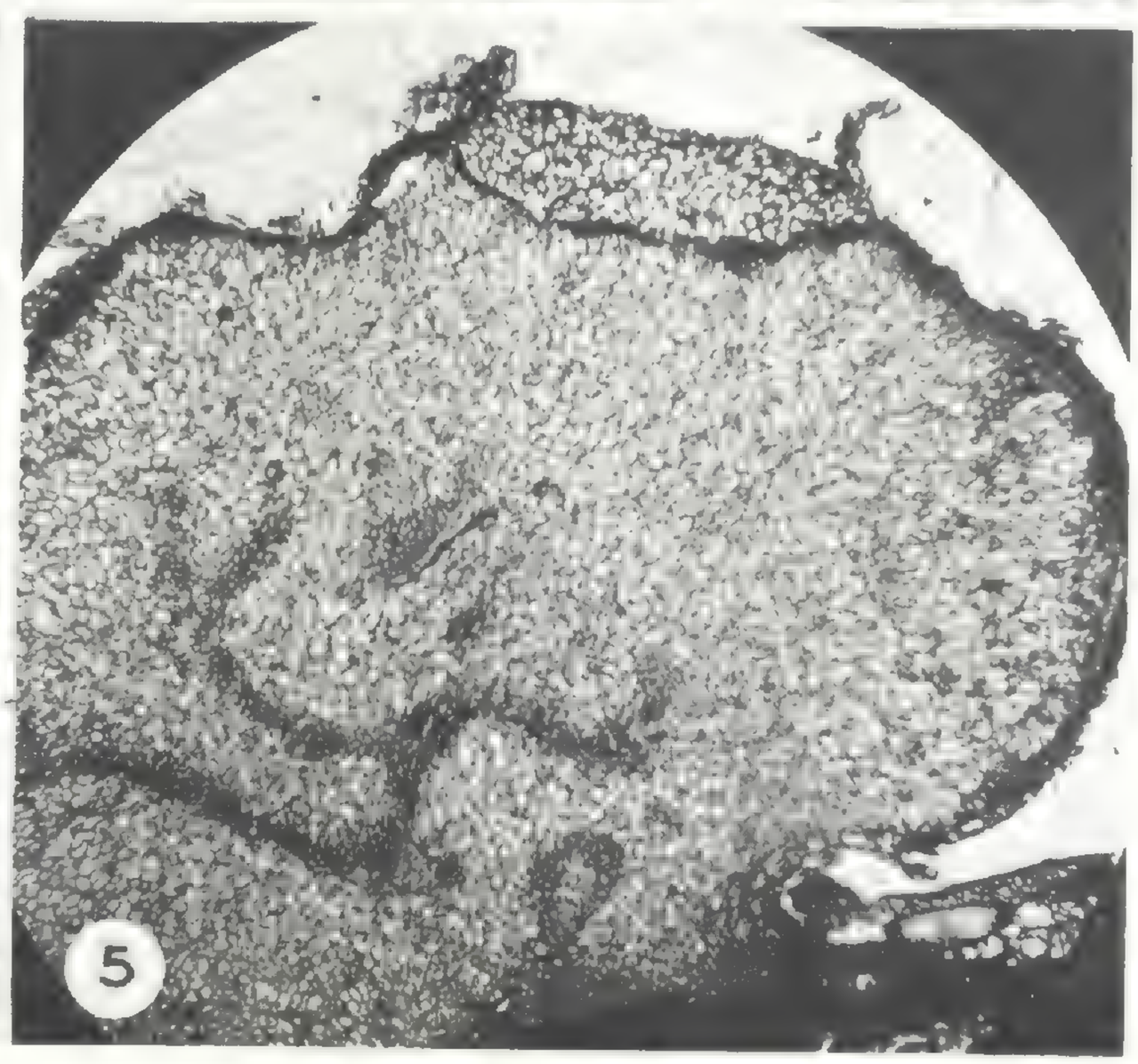

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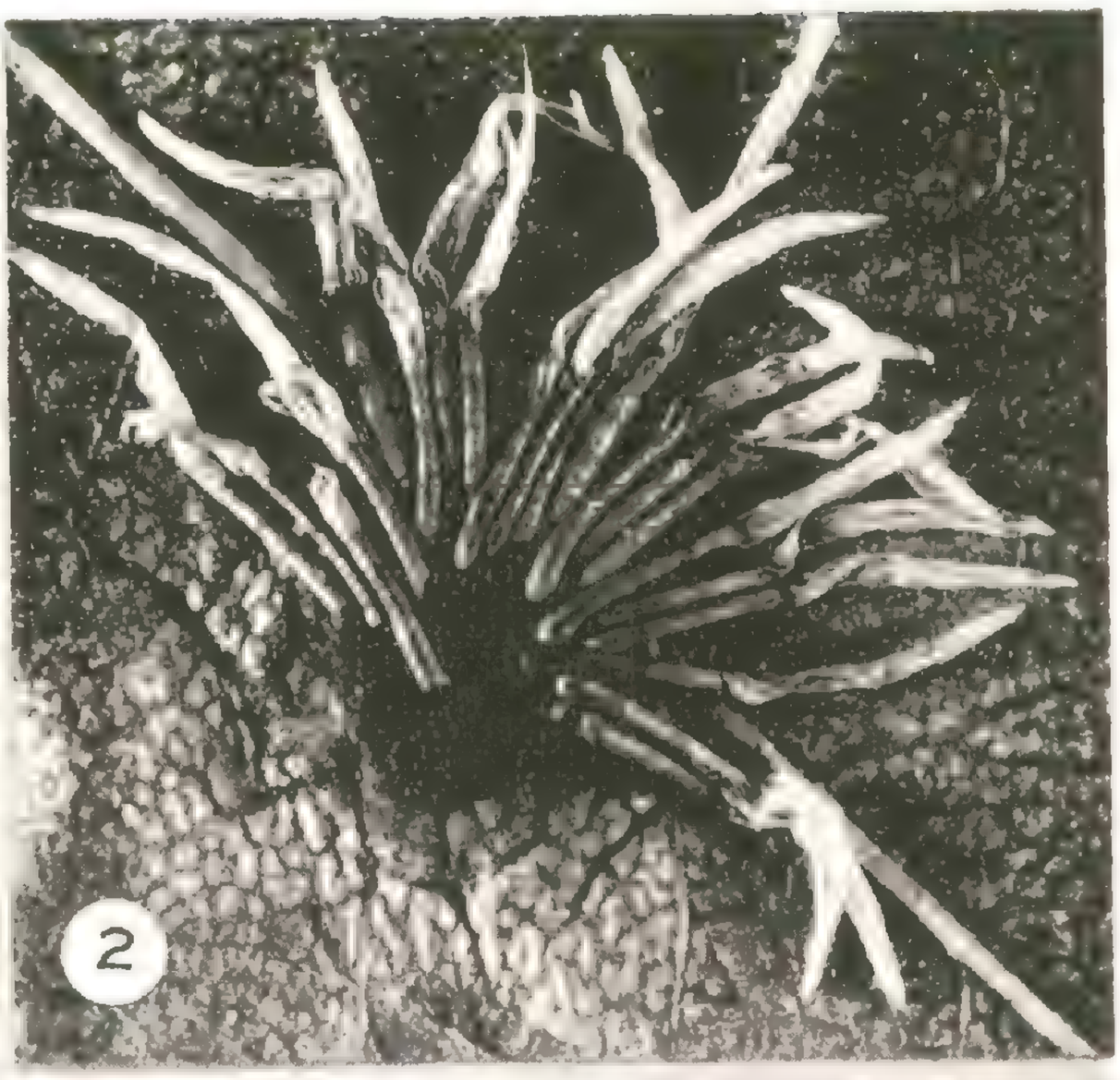
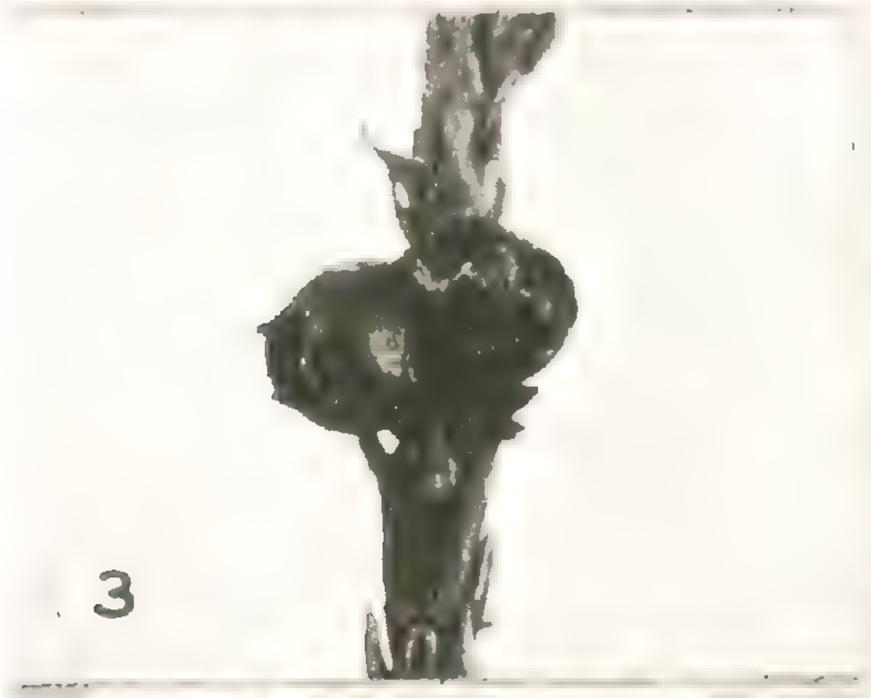
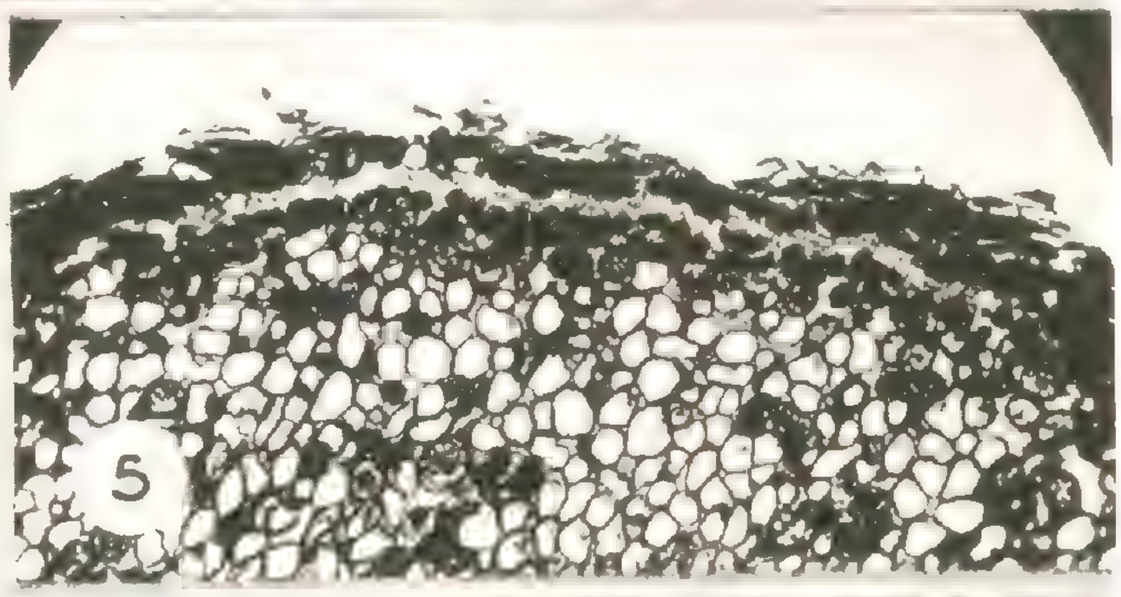
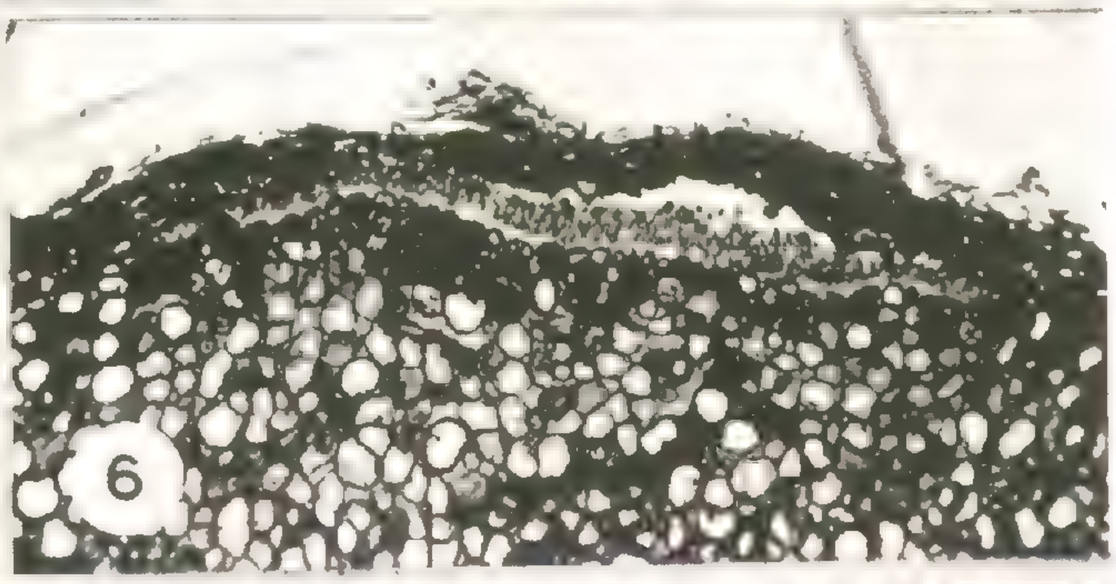
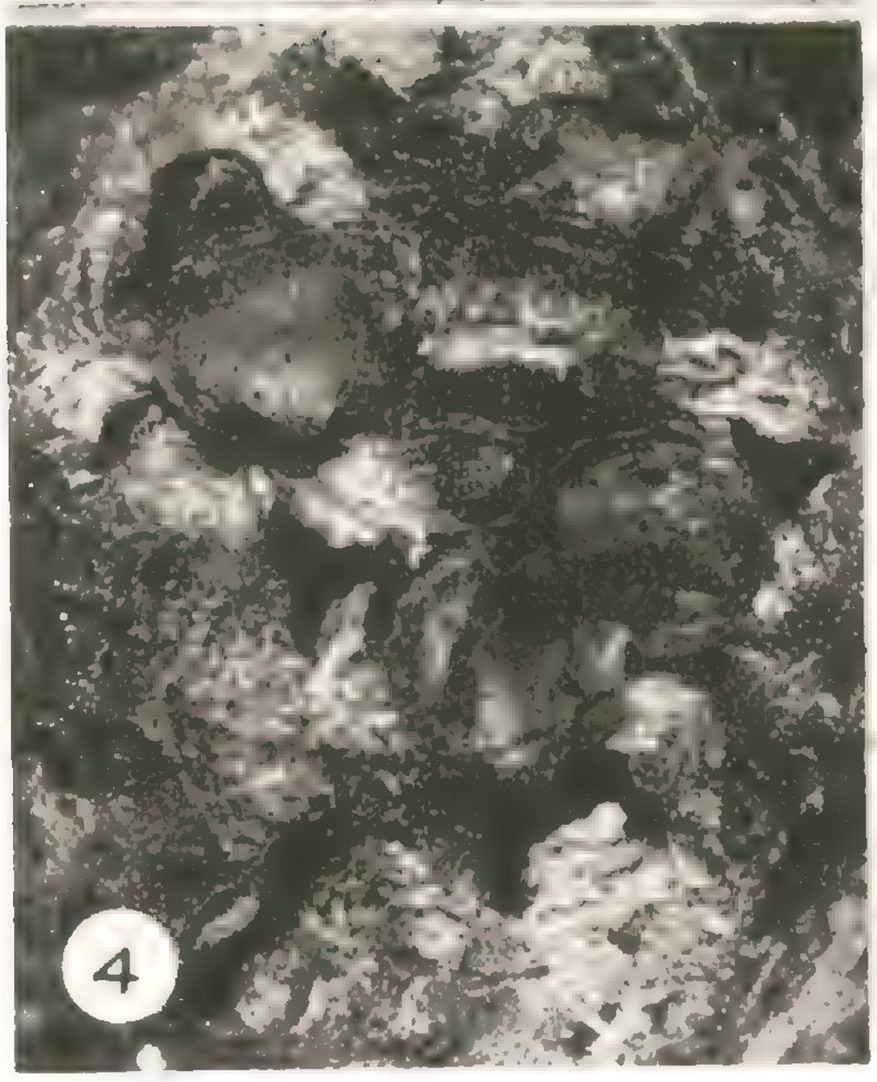
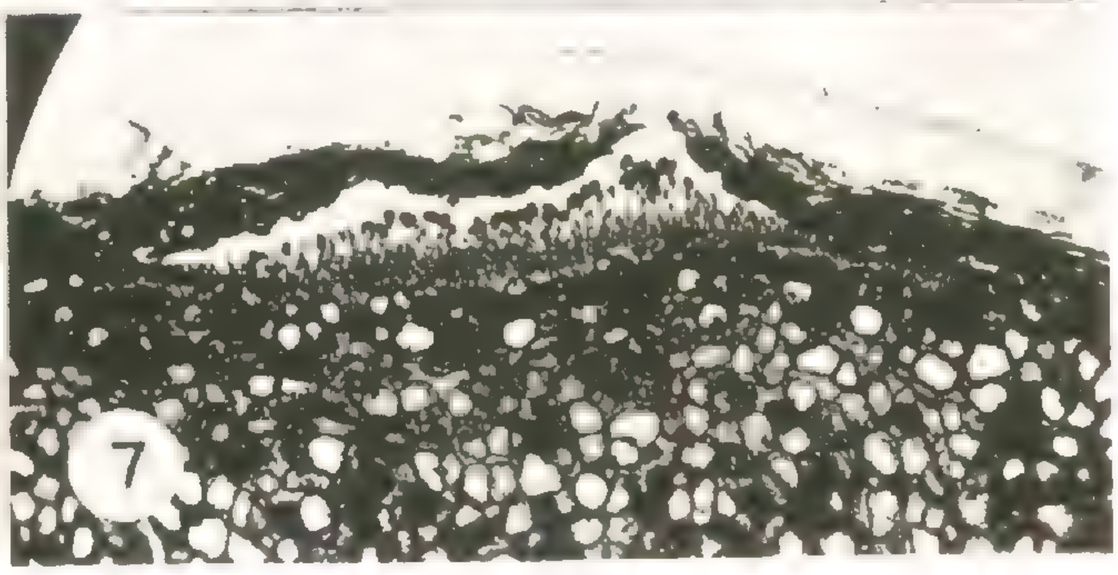






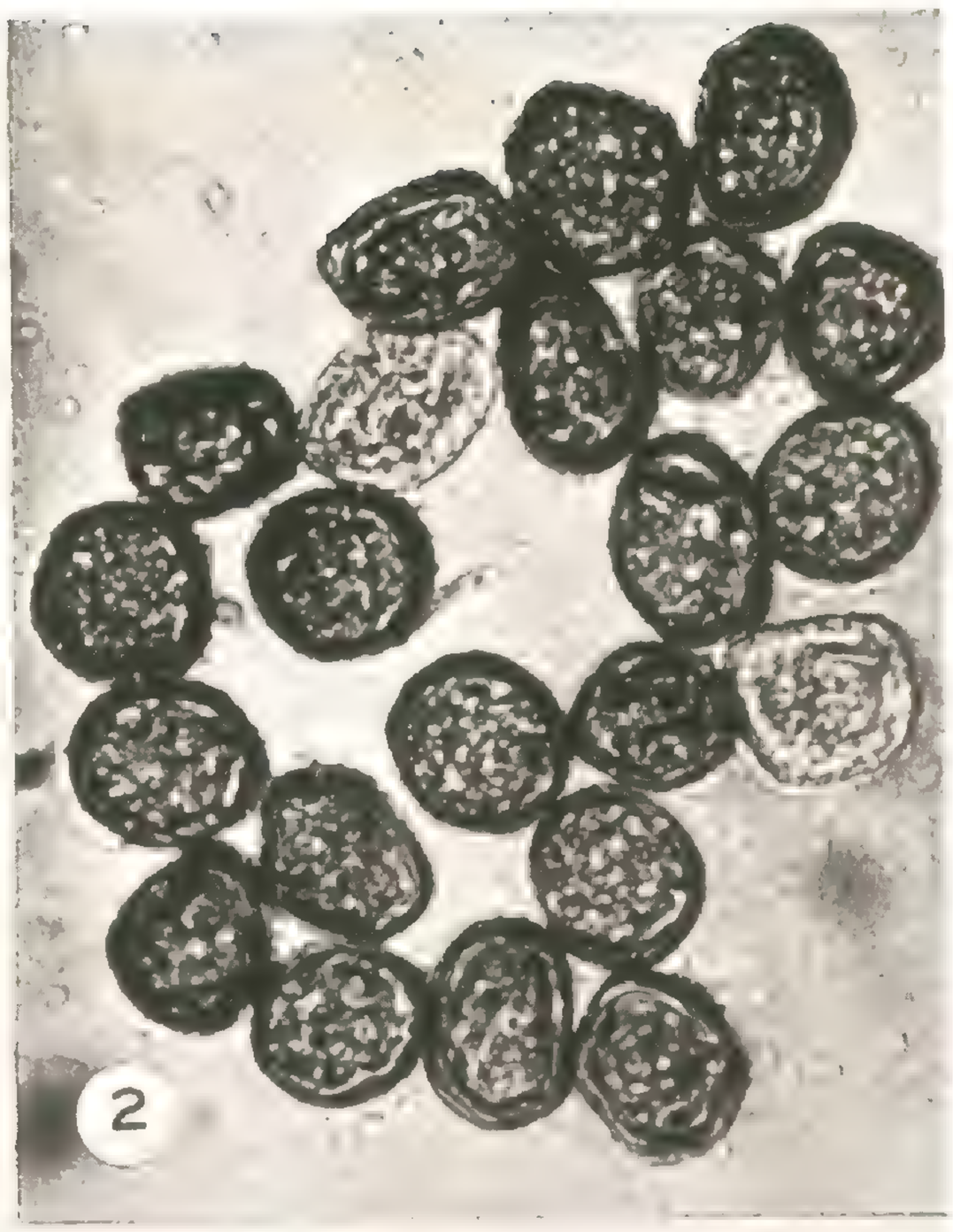




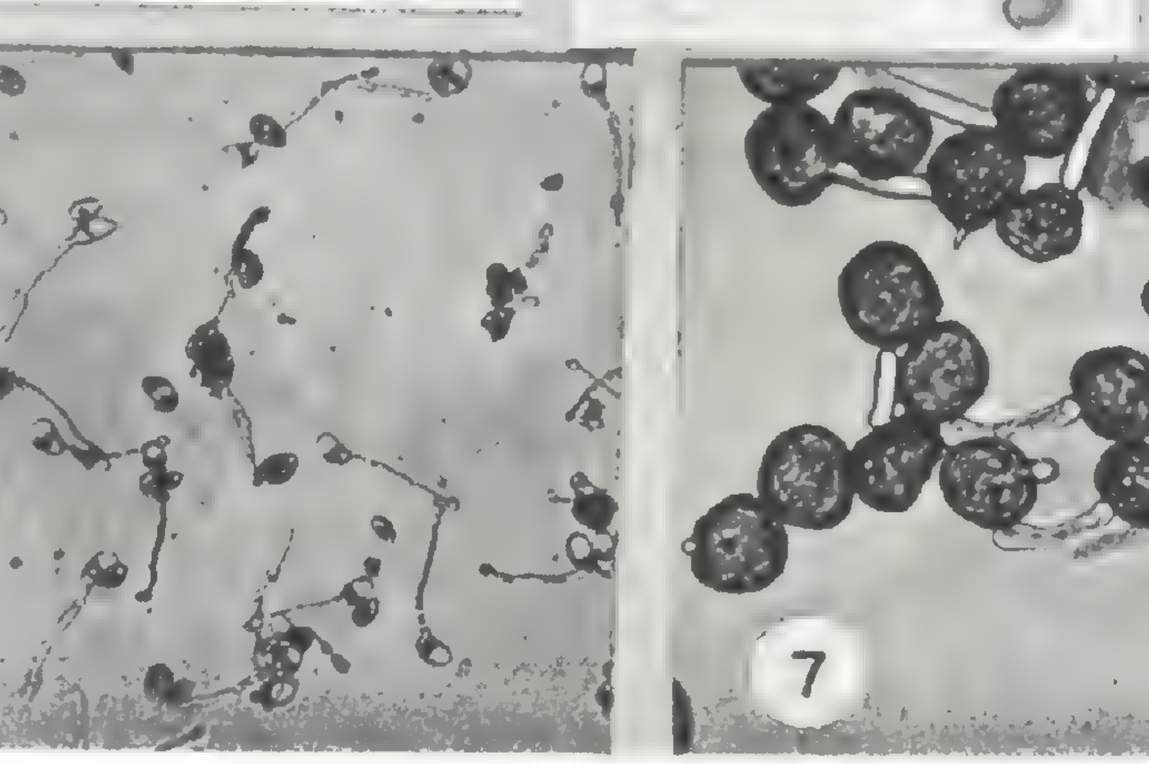


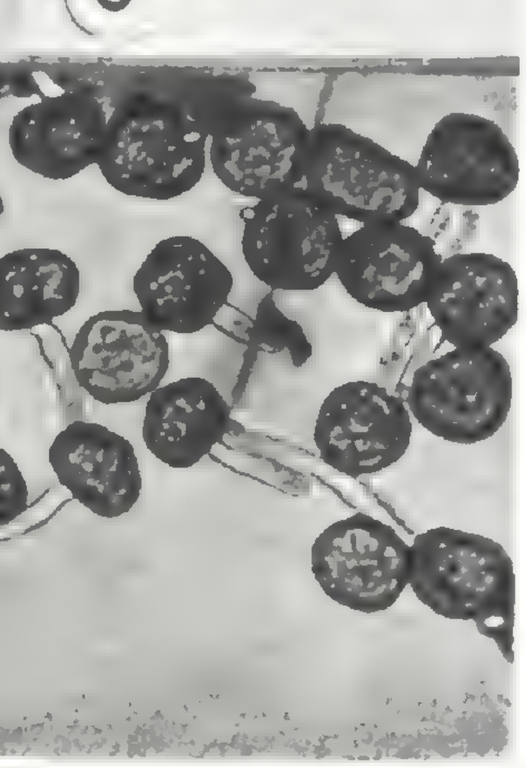
Gymnosporangium globosum Farl.

GYMNOSPORANGIUM GLOBOSUM Farl.

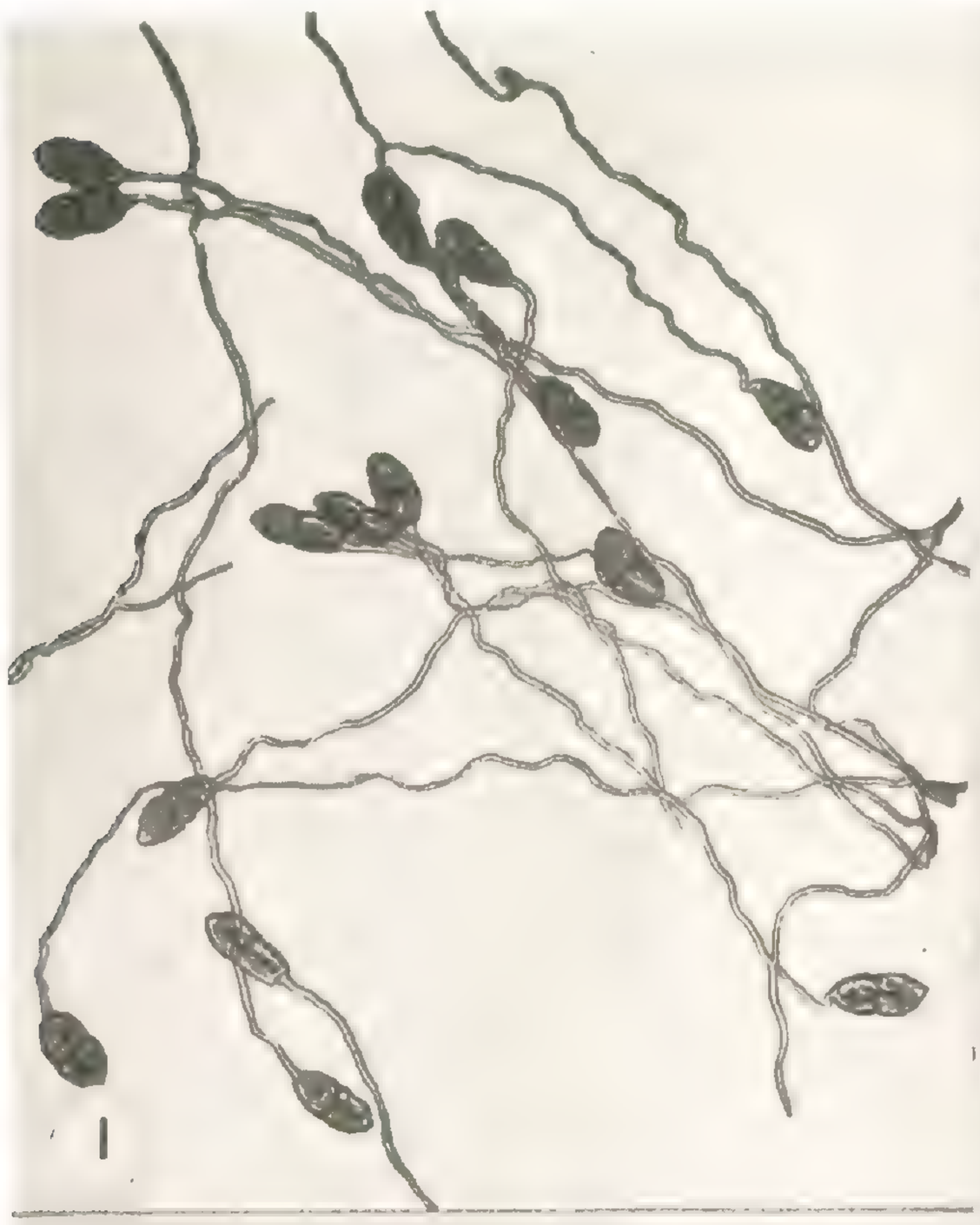


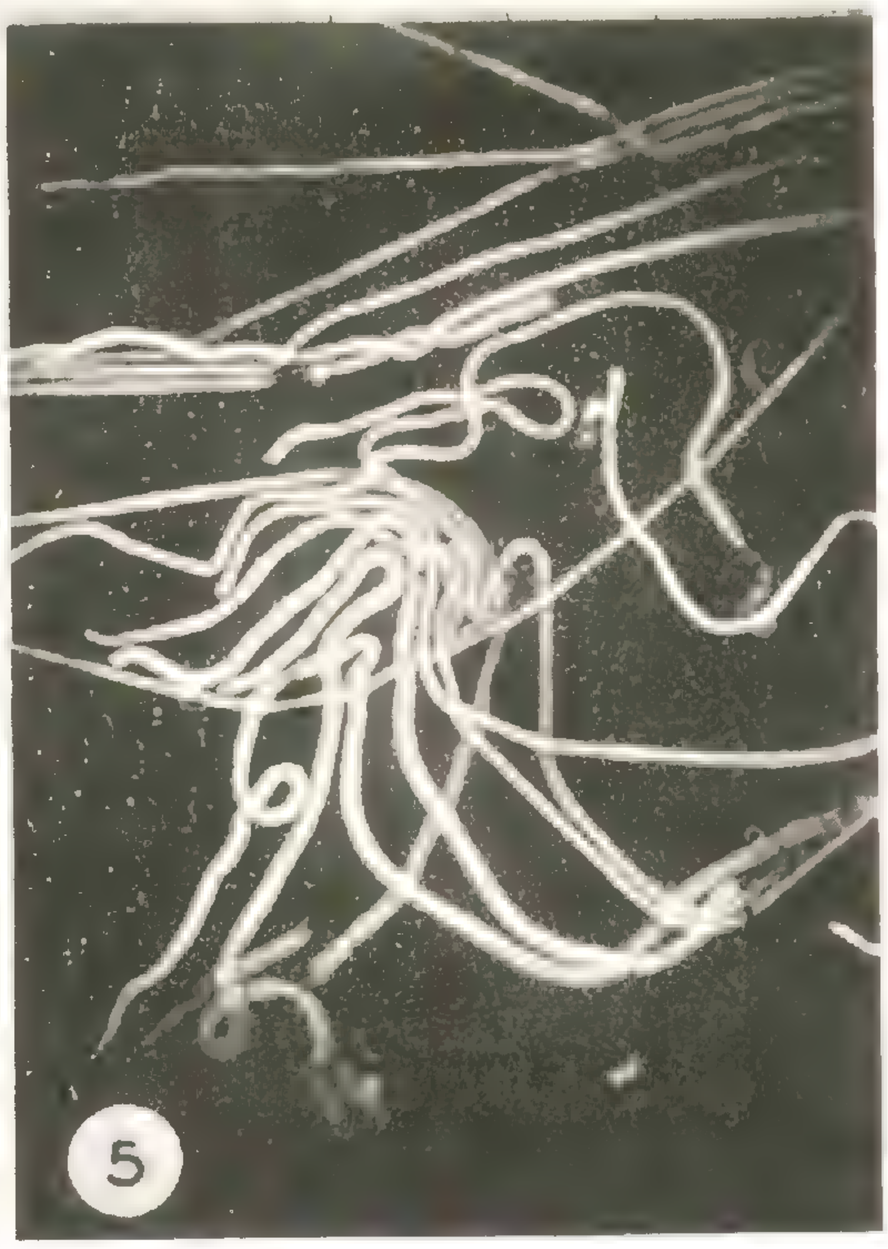
Gymnosporangium globosum Farl.





GYMNOSPORANGIUM GLOBOSUM Farl.





Gymnosporangium globosum Farl.

Plate 175

Teliospores of *G. globosum.*

Fig. 1. Pedicels and teliospores subjected to 95% alcohol for twelve hours. Note the slender thin-walled pedicels.

Fig. 2. Pedicels and teliospores subjected to water for twelve hours. The photograph is at a larger magnification than that of Fig. 1 (compare sizes of teliospores) but marked swelling of the pedicels has occurred; it is the swelling of these pedicels that causes the telial sori to swell during rainy periods in May. Note the air bubbles in the pedicel subtending the spore; these are in what was once the lumen but the latter has now lost its identity due to the swelling of the pedicel wall.

Fig. 3. Severe infection obtained on the foliage of *Crataegus Jonesae* Sarg., the result of inoculation using teliospores that had been kept in a refrigerator at 0° C. for one year.

Fig. 4. A teliospore and its pedicel that were subjected to 25% alcoholic methylene blue for fifteen hours. The wall of the pedicel did not stain but the stain is evident in the lumen.

Fig. 5. Portions of pedicels of teliospores. Some idea of their length may be obtained from this photograph.

Laboratory of Plant Pathology,
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THE LIFE HISTORIES OF MILESIA SCOLOPENDRII, M. POLYPODII, M. VOGESIACA AND M. KRIEGERIANA

LILLIAN M. HUNTER

With plate 176

HERETOFORE the life histories of ten species of *Milesia* in all have been determined more or less completely by Klebahn (12), Faull (3), Kamei (9, 10, 11) and Mayor (14). Four more are now added.

During the year 1933–4 it was my privilege to make studies on the genus *Milesia* in England. Through personal collecting and the help of others telial material of *Milesia Kriegeriana* (Magn.) Arth. on *Dryopteris spinulosa dilatata* (Hoffm.) Underw., *M. Polypodii* White on *Polypodium vulgare* L., *M. Scolopendrii* (Fuckel) Arth. on *Scolopendrium vulgare* Smith and *M. vogesiaca* (Syd.) Faull on *Polystichum angulare* Presl was obtained from Ireland, and the following from England—*M. Blechni* (Syd.) Arth. on *Blechnum Spicant* (L.) With., *M. carpatica* (Wrób.) Faull on *Dryopteris Filix mas* (L.) Schott and *D. spinulosa, M. Polypodii* on *Polypodium vulgare, M. Scolopendrii* on *Scolopendrium vulgare* and *M. Whitei* Faull on *Polystichum angulare*. My experiments were restricted to *M. Scolopendrii, M. Polypodii, M. vogesiaca* and *M. Kriegeriana*. All were obtained from overwintered fronds in the spring months of 1934. Teliospore formation began in late March and continued through April and May. It is of interest to record that search was made from October 1933 to early January 1934 for the teliospores of *M. Scolopendrii, M. Polypodii, M. Kriegeriana* and *M. Whitei;* but uredospores only were found.

The fern fronds bearing teliospores were sent in from the field and placed in a frigidaire, where they were kept at a temperature of approximately 11° C. It was found that the range of temperature over which germination of the teliospores took place was between 16° and 20° C. Material was prepared for germination in the usual way. Pieces of rust-affected fronds, spread out on wet absorbent paper in petri dishes, were tested for germination in constant temperature chambers set at various temperatures ranging between 15° and 30° C. Material set up in a similar way was left in the laboratory and a thermograph record was kept of the room temperature. Records show that teliospore germination was not secured when the temperature remained constantly above

20°; but if it dropped to 20° for a part of the time some germination was secured.

After the rusted fronds had been stored in the frigidaire they dried out noticeably; moistening before setting the teliospores to germinate was necessary. To do that the leaves were placed in tap water for a few minutes to an hour and then surplus water was removed by placing them between layers of absorbent paper before arranging them in petri dishes. Excellent germination was secured when the correct temperature and moisture conditions were maintained and basidia appeared within 14 hours to slightly over 3 days. Germination of teliospores was also obtained in Van Tieghem cells set up in the way described by Ashworth (1). The basidiospores germinated equally well on the cover glass in a thin film of moisture or on a plain agar film. With bean agar the results were not so satisfactory; normal germination did not take place and grotesque bodies formed on germination of the spores.

Basidiospores of the species of *Milesia* described in this paper are slightly attenuated at the point of detachment from the sterigma of the basidium. A very conspicuous oil drop is usually present in the basidiospore. Basidiospores of *M. Polypodii* (Plate 176, Fig. 1) tend to be more spherical than those of *M. Scolopendrii* (Fig. 2) and *M. Kriegeriana* (Fig. 3). A table of measurements made from living basidiospores is given below:

Species of rust	Shape of basidiospore	Breadth	Length
Milesia Polypodii	Spherical	8–12 μ	9–12 μ
Milesia Scolopendrii	Elongated	5–7 μ	10–12 μ
Milesia Kriegeriana	Elongated	5–8 μ	10–12 μ

In normal germination of basidiospores a germ tube is usually sent out laterally from the spore. This tube may be only a few microns long, ending in a short, bulbous, conidial-like body; or it may grow to a length of more than 90 μ (Fig. 4). Occasionally the contents of the basidiospore pass into the conidial-like body which increases in size as the protoplasm enters it, and the basidiospore wall collapses. A photomicrograph of a stained preparation showing basidiospores and basidiospore germination of *M. Polypodii* is shown in Fig. 5. Short germ tubes were put out two days after basidiospores were set to germinate and in from three to four days the tubes had attained a length of more than 90 μ. No further development was observed to occur when experiments were left much longer than four days. Occasionally, in addition to the usual long germ tube extending from one side of the basidiospore, a

TABLE I. RESULTS OF SUCCESSFUL INFECTION

	Date of inoculation	Host	First appearance of lesions	First appearance of spermogonia	First appearance of peridermia	Peridermia first ruptured	Date harvested	No. of needles infected	No. of needles with peridermia
Milesia Scolopendrii from *Scolopendrium vulgare* to *Abies*	27.IV.34	*Abies alba*	26 days	26 days	54 days	75 days	94 days	10	7
	27.IV.34	*Abies alba*	25 days	25 days	54 days	67 days	70 days	32	14
	2.V.34	*Abies alba*	21 days	21 days	78 days	89 days	101 days	70	65
	30.VI.34	*Abies alba*	23 days	23 days	—	—	—	—	Tree wilted before peridermia were fully developed.
	4.VI.34	*Abies concolor*	29 days	29 days	62 days	75 days	75 days	34	Peridermia insect eaten.
Milesia Polypodii from *Polypodium vulgare* to *Abies*	2.V.34	*Abies alba*	26 days	26 days	80 days	89 days	101 days	17	17
	28.V.34	*Abies concolor*	21 days	25 days	—	—	82 days	34	Peridermia insect eaten, mostly immature.
	1.VI.34	*Abies concolor*	26 days	26 days					
Milesia vogesiaca from *Polystichum angulare* to *Abies*	30.IV.34	*Abies alba*	23 days	23 days	—	—	62 days	24	Tree wilted before peridermia developed.
	2.V.34	*Abies alba*	21 days	21 days	93 days	99 days	108 days	36	28

TABLE 1. RESULTS OF SUCCESSFUL INFECTION (continued)

	Date of inoculation	Host	First appearance of lesions	First appearance of spermogonia	First appearance of peridermia	Peridermia first ruptured	Date harvested	No. of needles infected	No. of needles with peridermia
Milesia Kriegeriana from *Dryopteris spinulosa* to *Abies*	2.V.34	*Abies alba*	—	—	49 days	57 days	65 days	6	5
	5.VI.34	*Abies concolor*	22 days	22 days	49 days	—	55 days	14	14
	6.V.34	*Abies grandis*	24 days	24 days	—	—	—	—	Peridermia did not develop.
	7.V.34	*Abies grandis*	21 days	21 days	37 days	46 days	60 days	13	8
	9.V.34	*Abies grandis*	21 days	21 days	44 days	—	52 days	19	17
Milesia Kriegeriana from *Dryopteris Filix-mas* to *Abies*	1.VI.34	*Abies alba*	21 days	21 days	—	—	—	—	Insect eaten.
	1.VI.34	*Abies alba*	21 days	21 days	—	—	—	—	Leaf disappeared.
	28.V.34	*Abies concolor*	21 days	21 days	57 days	60 days	82 days	38	38
	28.V.34	*Abies concolor*	30 days	30 days	57 days	60 days	63 days	23	20
	24.V.34	*Abies grandies*	21 days	21 days	56 days	71 days	86 days	2	2

bulbous body was put out from the other side of the spore (Fig. 4). Normal germination of basidiospores was as high as 90 per cent.

The basidiospores stuck so fast to the surface on which they fell, regardless of whether they alighted on agar or on the cover glass in a thin layer of moisture, that they remained on the slides without requiring the use of egg albumen or other adhesive to secure them during the process of staining in iron alum haematoxylin. A study was made of stained germinated basidiospores and it was found that from two to four nuclei were in the germ tubes (Fig. 6).

Abies alba Mill., *A. concolor* Lindl. & Gord., *A. grandis* Lindl., *A. Nordmanniana* (Stev.) Spach, *A. Veitchii* Lindl., *A. firma* Sieb. & Zucc. and *Picea pungens* Engelm. were used for inoculation purposes. Trees, three and four years old, were secured through the Forestry Commission, London, and through reliable nurseries. Some of these were planted in pots and placed in greenhouses at the Chelsea Physic Garden, London, and some in the open at the Biological Station, Imperial College, Slough, Bucks. Hubert's tube method as re-described by Faull (3) was used in making inoculations. In some cases the trees were so small that it was impossible to flex the short branches without breaking them, so in connection with these trees the teliospore inoculum was suspended from above so that the basidiospores fell directly upon the upper rather than the lower surface of the leaves. Experiments carried on in both ways gave successful results. Large celluloid tubes stuffed with wet sphagnum at either end to ensure a moist atmosphere were used to entirely enclose the smaller trees. Of all the species used, *A. alba, A. concolor* and *A. grandis* only gave positive results. The infected needles of *A. concolor* were slightly distorted but those of *A. alba* and *A. grandis* were not (cf. Faull, 3).

Successful infection results were obtained by the writer (7) for the following species:—(1) *Milesia Scolopendrii* on *Abies alba* and *A. concolor;* (2) *M. Polypodii* on *A. alba* and *A. concolor;* (3) *M. vogesiaca* on *A. alba;* (4a) *M. Kriegeriana* (from *Dryopteris spinulosa*) on *A. alba, A. concolor* and *A. grandis;* (4b) *M. Kriegeriana* (from *Dryopteris Filix mas*) on *A. alba, A. concolor* and *A. grandis.* Data on the experiments are assembled in Table I. One fir tree, simultaneously and under what were essentially identical conditions, bore four successful infections—each from a different rust species. The variations shown with regard to the periods of time that elapsed between inoculation and the first appearance of spermogonia and peridermia were similar to those recorded in the tables for the respective species. Many more inoculations than those recorded were later set up between June 6 and July 6 but no visible infection was observed.

TABLE II. *Milesia Scolopendrii* from *Abies to* Various Ferns

Fern inoculated	From *Abies*	Date of inoculation	Date harvested	Time from inoculation to appearance of uredinia	Results
Scolopendrium vulgare	*A. alba*	7.VII.34	30.VIII.34	54 days	Uredinia
" "	" "	7.VII.34	30.VIII.34	54 days	Uredinia
" "	" "	24.VII.34	15.IX.34	53 days	Uredinia
" "	" "	24.VII.34	30.VIII.34	37 days	Uredinia
" "	" "	11.VIII.34	18.IX.34	38 days	Uredinia
" "	" "	11.VIII.34	18.IX.34	38 days	Uredinia
Blechnum Spicant	" "	24.VII.34	19.X.34	—	No infection
Dryopteris spinulosa dilatata	" "	11.VII.34	19.X.34	—	No infection
Polystichum angulare	" "	7.VII.34	19.X.34	—	No infection
" "	" "	11.VIII.34	19.X.34	—	No infection

TABLE III. *Milesia Polypodii* from *Abies* to Various Ferns

Fern inoculated	From *Abies*	Date of inoculation	Date harvested	Time from inoculation to appearance of uredinia	Results
Polypodium vulgare	*A. alba*	30.VII.34	15.IX.34	47 days	Uredinia
" "	" "	30.VII.34	15.IX.34	47 days	Uredinia, infection very slight
" "	" "	11.VIII.34	18.X.34	68 days	Uredinia
" "	" "	11.VIII.34	19.X.34	69 days	No uredinia but rust mycelium present
Polystichum angulare	" "	11.VIII.34	19.X.34	—	No infection
Scolopendrium vulgare	" "	30.VII.34	19.X.34	—	No infection

TABLE IV. *Milesia Kriegeriana* (from *Dryopteris Filix mas*) from *Abies* to Various Ferns

Fern inoculated	From *Abies*	Date of inoculation	Date harvested	Time from inoculation to appearance of uredinia	Results
Dryopteris Filix-mas	*A. concolor*	30.VII.34	15.IX.34	47 days	Uredinia
" " "	" "	30.VII.34	15.IX.34	47 days	Uredinia, insect eaten
" " "	" "	18.VIII.34	15.IX.34	28 days	Uredinia
Dryopteris spinulosa	" "	30.VII.34	30.VIII.34	31 days	Uredinia
" "	" "	18.VIII.34	19.X.34	—	No infection

TABLE V. *Milesia Kriegeriana* (from *Dryopteris*) from *Abies* to Various Ferns

Fern inoculated	From *Abies*	Date of inoculation	Date harvested	Time from inoculation to appearance of uredinia	Results
A. From *D. spinulosa* and *D. spinulosa dilatata*					
Dryopteris Filix-mas	*A. grandis*	30.VI.34	31.VIII.34	64 days	Uredinia
Dryopteris spinulosa	*A. grandis*	30.VI.34	31.VIII.34	64 days	Uredinia, very slight infection
B. From *D. spinulosa dilatata*					
Dryopteris spinulosa dilatata	*A. alba*	27.VI.34	31.VIII.34	—	No infection
" "	*A. concolor*	30.VII.34	31.VIII.34	32 days	Uredinia
" "	*A. concolor*	30.VII.34	19.X.34	—	No infection
Dryopteris Filix-mas	*A. concolor*	30.VII.34	31.VIII.34	32 days	Uredinia
Dryopteris spinulosa intermedia	*A. concolor*	30.VII.34	15.IX.34	47 days	Uredinia

Ferns for inoculation experiments were procured from Perry's Hardy Plant Farm and from the field in Devon. Those from Devon were obtained between April 1 and 23. An endeavor was made to select plants that were not already rusted. All the overwintered fronds were cut away fairly close to the underground stem but the young unfolded fronds attached to the stem were left untouched. They were planted in pots at the Biological Station, Slough, in a shaded part of the garden well removed from firs. No rust was observed on any of the ferns as late as August 19, so it is thought that if the ferns from Devon bore natural infection there should have been evidence of it before that date. No naturally occurring ferns bearing rusts were found at the Biological Station.

Aeciospores from culture experiments were used in inoculating various ferns with the result that uredospores were obtained for the following species—(1) *Milesia Scolopendrii* on *Scolopendrium vulgare;* (2) *M. Polypodii* on *Polypodium vulgare;* (3a) *M. Kriegeriana* (from *Dryopteris spinulosa*) on *Dryopteris Filix-mas, D. spinulosa, D. spinulosa dilatata* and *D. spinulosa intermedia* (Muhl.) Underw.; (3b) *M. Kriegeriana* (from *Dryopteris Filix-mas*) on *Dryopteris Filix-mas* and *D. spinulosa.* Data on the experiments are assembled in Tables II to V.

The successful culturing of *Milesia Scolopendrii, M. Polypodii, M. vogesiaca* and *M. Kriegeriana* on their alternate hosts now makes possible a completion of the description of these rusts. The uredinial (2, 4–6) and telial (2) phases have already been adequately described. Heretofore the spermogonial and the aecial phases of *M. Scolopendrii, M. Polypodii* and *M. vogesiaca* have remained wholly unknown; and the same phases of *M. Kriegeriana* have been described by Mayor (14) from field collections only, a part of the material of which was used in making successful cultures on the fern host—material not free from the uncertainty of intermixtures. The spermogonia and the aecia of these four species are described below from the writer's culture material on *Abies*, that is, from what is known to be authentic, representative material.

(1) **Milesia Scolopendrii**

O. Spermogonia on needles of current season, epiphyllous and hypophyllous, immersed, abundant, inconspicuous, colorless, plane, hemispherical to slightly flask-shaped in sectional view, subcuticular, 120–228 μ broad by 100–188 μ high; spermatia hyaline, narrowly elliptical, 1.5–2.0 × 4–5 μ.

I. Aecia hypophyllous on needles of current season, in two irregular rows, one on each side of midrib, white, cylindrical, 0.4–0.5 mm. in diameter by 0.7–1.5 mm. high; peridium colorless, delicate, rupturing at the apex; peridial cells polygonal, elongated vertically, overlapping, in a single layer, 20–36 × 28–56 μ, with outer walls smooth, and inner walls finely and densely warted, the warts arranged in elevated, short lines; aeciospores ellipsoid, ovoid or globose, mostly elongated, white, 22–44 × 28–48 μ, very densely and rather coarsely verrucose with warts irregular in outline, tapering to a blunt point and somewhat deciduous; walls hyaline, thin, about 1 μ thick.

(2) **Milesia Polypodii**

O. Spermogonia on needles of current season, epiphyllous and hypophyllous, immersed, abundant, inconspicuous, colorless, plane, hemispherical to slightly flask-shaped in sectional view, subcuticular, 120–228 μ broad by 105–194 μ high, usually broader than high; spermatia hyaline, narrowly elliptical, 1.5–2.0 × 4–5 μ.

I. Aecia hypophyllous on needles of current season, in two irregular rows, one on each side of midrib, on slightly yellowish discolored portions of affected needles, white, cylindrical, 0.5–0.7 mm. in diameter by 1.0–1.5 mm. high; peridium colorless, delicate, rupturing at the apex; peridial cells polygonal, elongated vertically, overlapping, in a single layer, 22–42 × 28–60 μ, with outer walls smooth and inner walls with elevated, coarse, short, irregularly oriented ridges; aeciospores ellipsoid, ovoid or globose, mostly elongated, white, 20–36 × 28–54 μ, densely and rather coarsely warted, warts irregular in outline, tapering to a very blunt point and somewhat deciduous; walls hyaline, thin, about 1 μ thick.

(3) **Milesia vogesiaca**

O. Spermogonia on needles of current season, epiphyllous and hypophyllous, mostly epiphyllous, very abundant, immersed, inconspicuous, colorless, plane, 154 241 μ broad by 168–214 μ high, spherical to slightly flask-shaped in sectional view, subcuticular; spermatia hyaline, narrowly elliptical, 1.5–2.0 × 4–5 μ.

I. Aecia hypophyllous on needles of current season, in two irregular rows, one on each side of midrib on slightly yellowish discolored portions of affected needles, white, cylindrical, 0.5–0.7 mm. in diameter by 0.6–1.0 mm. high; peridium colorless, delicate, rupturing at the apex; peridial cells polygonal, elongated vertically, overlapping, in a single layer, 20–32 × 32–48 μ, with outer walls smooth and inner walls warted or with elevated, coarse, short, irregularly oriented ridges; aeciospores

ellipsoid, ovoid or globose, mostly elongated, white, 24–30 × 32–46 μ, densely warted, warts very irregular in outline and tapering to a very blunt point, somewhat deciduous; walls hyaline, thin, about 1 μ thick.

(4) **Milesia Kriegeriana**

O. Spermogonia on needles of current season, epiphyllous and hypophyllous, mostly epiphyllous, numerous, irregularly scattered, inconspicuous, colorless, plane, abundant, immersed, hemispherical in sectional view, subcuticular, 98–168 μ broad by 94–168 μ high; spermatia narrowly elliptical, 1.5–2.0 × 3.5–5.0 μ.

I. Aecia hypophyllous on needles of current season, in two irregular rows on slightly yellowish discolored portions of affected needles, subcircular, ellipsoid or compressed laterally in transverse section, cylindrical, 0.3–0.8 mm. in diameter by 0.5–1.3 mm. high; peridium colorless, delicate, rupturing at the apex; peridial cells polygonal, elongated vertically, overlapping, in a single layer, 16–52 × 32–68 μ, with outer walls smooth and inner walls with fine elevated ridges, irregularly oriented; aeciospores ellipsoid, ovoid or globose, mostly elongated, white, 20–36 × 22–48 μ, finely warted, warts tapering to a blunt point, somewhat deciduous; walls hyaline, thin, about 1 μ thick.

Mayor (14) refers to the late appearance of the aecia from natural infection in the field and believes that the younger needles of *Abies* are not susceptible to *Milesia Kriegeriana*. It would seem from the writer's experience that the late appearance of the aecia of *M. Kriegeriana* is because of the long period of development of the fungus from the time of inoculation until the peridermia make their appearance and that young leaves are more susceptible to the rust than older ones.

A comparison of the foregoing descriptions shows that these rusts cannot be separated on morphological differences in their peridermia but, on the other hand, that the spermogonia do afford some help. The spermogonia of *Milesia Scolopendrii* and *M. Polypodii* are hemispherical to slightly flask-shaped while those of *M. vogesiaca* are spherical to slightly flask-shaped, and are on the average much larger. The spermogonia of *Milesia Kriegeriana* are hemispherical in shape and are on the average consistently smaller than those of the other three species. The subcuticular areas directly overlying the spermogonia of *M. Kriegeriana*, *M. Polypodii* and *M. Scolopendrii* are relatively greater than that in *M. vogesiaca*. Indeed in *M. vogesiaca* the area is so small that in lateral vertical sections the spermogonium appears to be subepidermal. The spermogonia of *M. Scolopendrii* and *M. Polypodii* are much alike in form and size, although those of the latter are on the average a little larger. The detailed data are recorded in a paper to be published soon.

SUMMARY

1. By means of controlled cultures the O I stages of *Milesia Scolopendrii, M. Polypodii, M. vogesiaca* and *M. Kriegeriana* have been obtained for the first time.

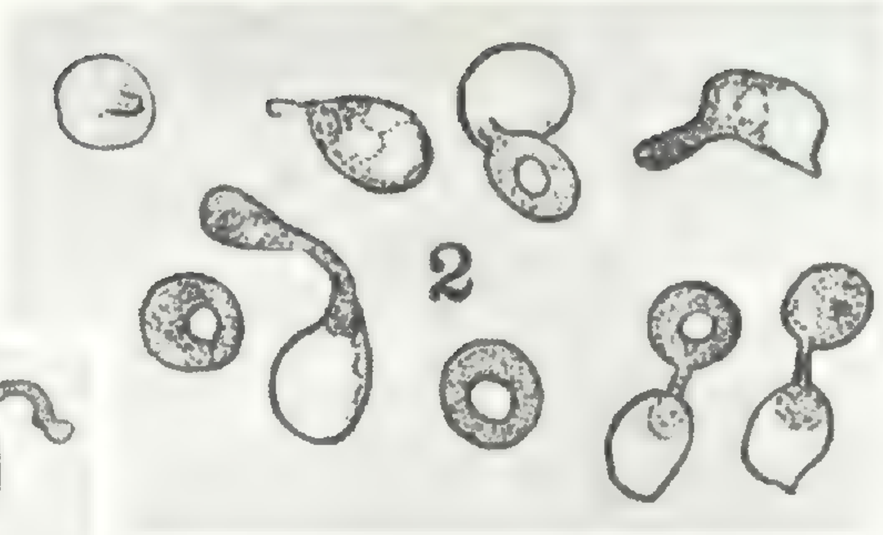
	O I hosts	II III hosts
(1) *Milesia Scolopendrii*	*Abies alba, A. concolor*	*Scolopendrium vulgare*
(2) *Milesia Polypodii*	*Abies alba, A. concolor*	*Polypodium vulgare*
(3) *Milesia vogesiaca*	*Abies alba*	*Polystichum angulare*
(4a) *Milesia Kriegeriana* (from *Dryopteris spinulosa*)	*Abies alba, A. concolor, A. grandis*	*Dryopteris spinulosa, D. spinulosa dilatata, D. spinulosa intermedia, D. Filix-mas*
(4b) *Milesia Kriegeriana* (from *Dryopteris Filix-mas*)	*Abies concolor*	*Dryopteris spinulosa, D. Filix-mas*

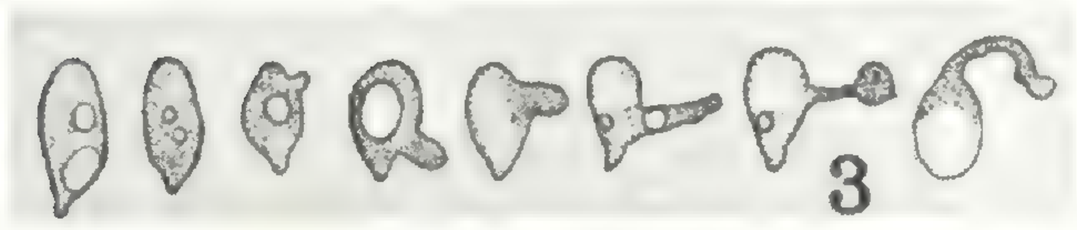
2. The spermogonia and the aecia of *M. Scolopendrii, M. Polypodii* and *M. vogesiaca* are described for the first time. The spermogonia and the aecia of *M. Kriegeriana* are described for the first time from culture material.

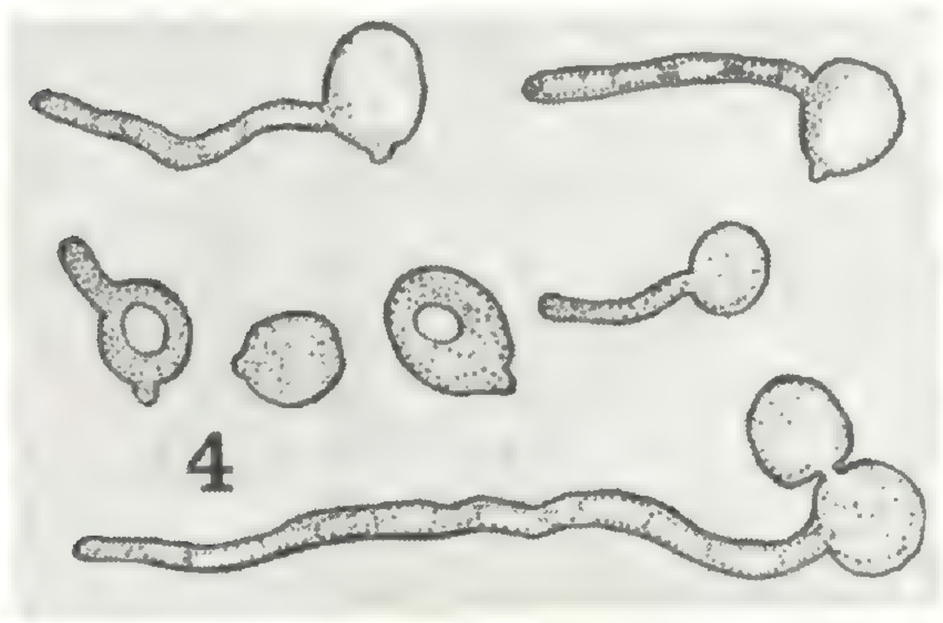
3. The spermogonia of *M. Kriegeriana* and *M. vogesiaca* are distinguishable by their form and size from one another and from those of *M. Scolopendrii* and *M. Polypodii*. The spermogonia of *M. Scolopendrii* and *M. Polypodii* are similar in form and size.

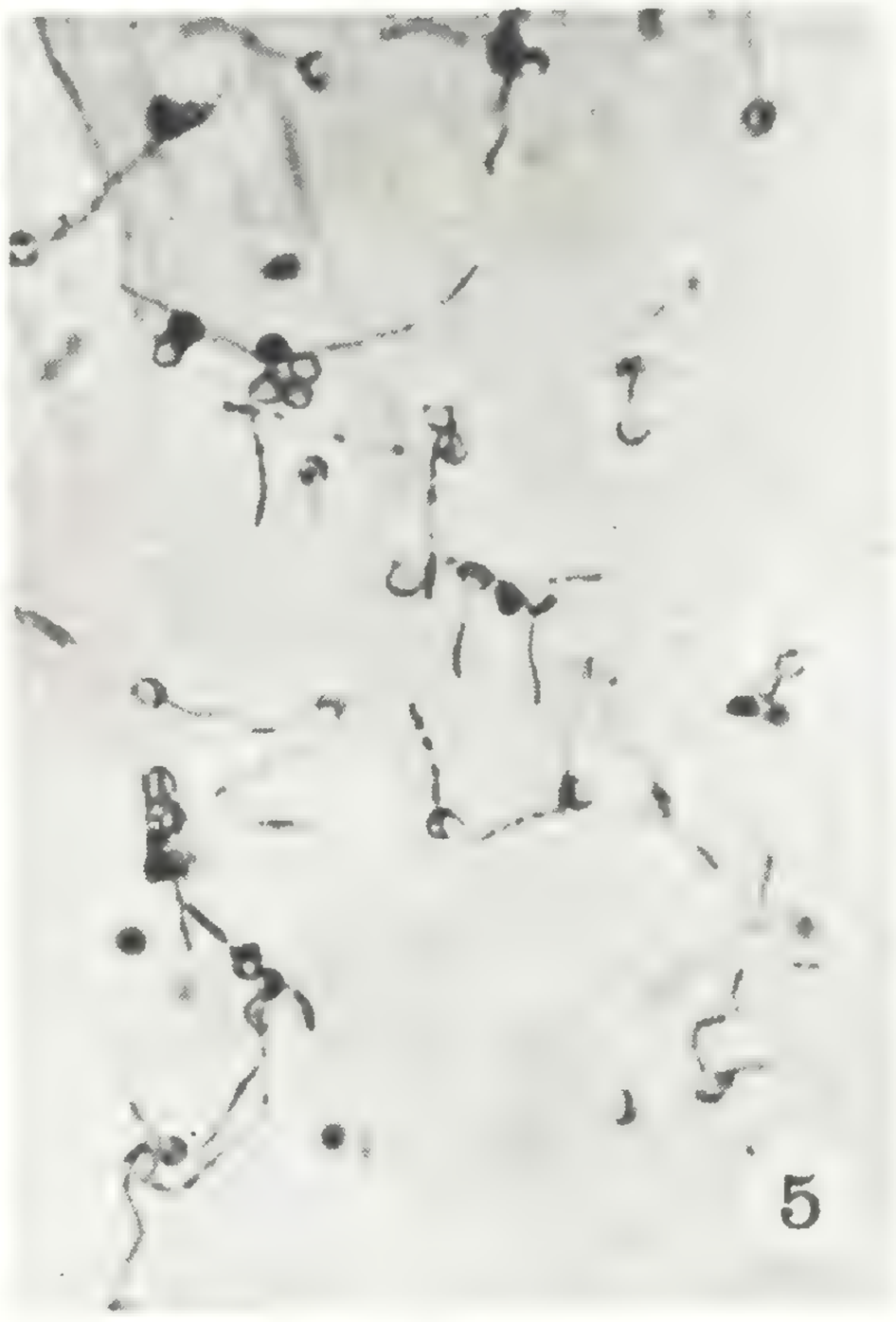
ACKNOWLEDGMENTS

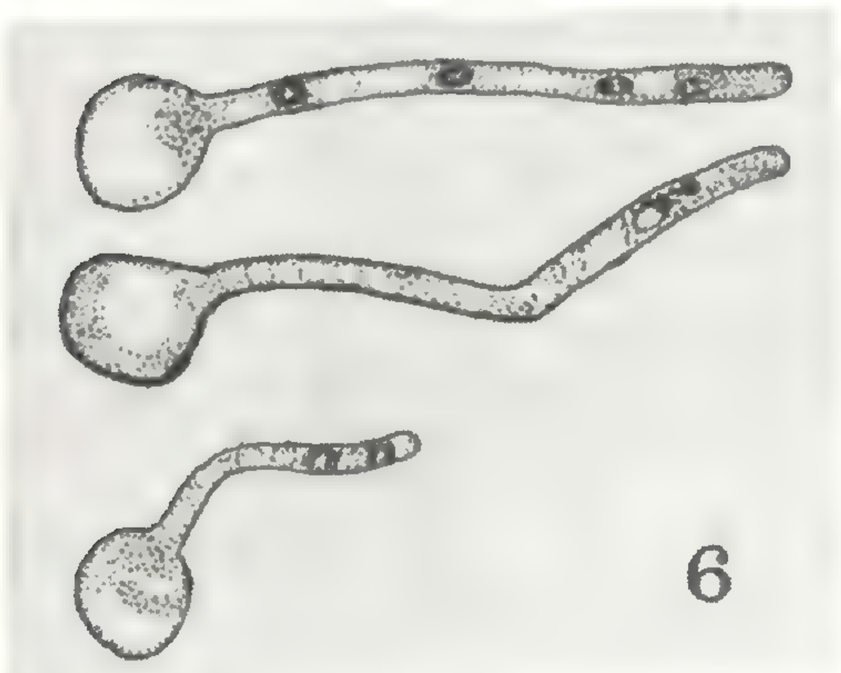
Studies recorded in this paper form part of an investigation carried out by the writer under the direction of Professor J. H. Faull of the Arnold Arboretum, Harvard University. This particular phase of the work was made possible by a fellowship granted by the Canadian Federation of University Women and was mostly done in England under the sponsorship of Professor William Brown of the Imperial College of Science and Technology, London University. Sincere thanks are tendered to Professors Brown and Faull. The author also gratefully acknowledges various services rendered by Mrs. L. Allen, Mr. D. Blockey, Dr. G. D. Darker, Dr. E. Milton, Mr. H. B. S. Montgomery, Dr. Muriel P. Hall, Dr. P. O'Connor, Mr. A. H. G. Alston, Mr. W. Hales, Mr. W. Williams, Mr. J. Ramsbottom, Mr. A. D. Cotton, Miss E. M. Wakefield, Dr. E. J. Butler, Mr. E. W. Swanton, Mr. J. Ogilvie, the Torquay Museum of Natural History and the Forestry Commission of Great Britain.











MILESIA POLYPODII, M. SCOLOPENDRII, M. KRIEGERIANA AND M. VOGESIACA

FULL-TONE — MERIDEN

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EXPLANATION OF PLATE 176

Fig. 1. Basidiospores of *Milesia Polypodii* B. White. Note variation in form and germination. × 495.

Fig. 2. Basidiospores of *Milesia Scolopendrii* (Fuckel) Arth. Note variation in form and germination. × 495.

Fig. 3. Basidiospores of *Milesia Kriegeriana* (Magn.) Arth. from *Dryopteris Filix-mas* (L.) Schott. Note variation in form and germination. × 480.

Fig. 4. Germinating basidiospores of *Milesia Polypodii*. Note the various stages in germination and the formation of a secondary spore. × 495.

Fig. 5. Germinating basidiospores of *Milesia Polypodii*. × 200.

Fig. 6. Germinating basidiospores of *Milesia Polypodii*. Note nuclei in germ tubes. × 495.

Fig. 7. Young tree of *Abies alba* Mill. infected with four species of *Milesia*, namely,—(1) *M. Polypodii* on upper left branch (inoculation experiment No. 7); (2) *M. vogesiaca* (Syd.) Faull on upper right branch (inoculation experiment No. 8); (3) *M. Kriegeriana* on lower left branch (inoculation experiment No. 9); (4) *M. Scolopendrii* on lower right branch (inoculation experiment No. 10). × ¾.

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A CONVENIENT SAND-CULTURE APPARATUS

ROBERT W. WARD

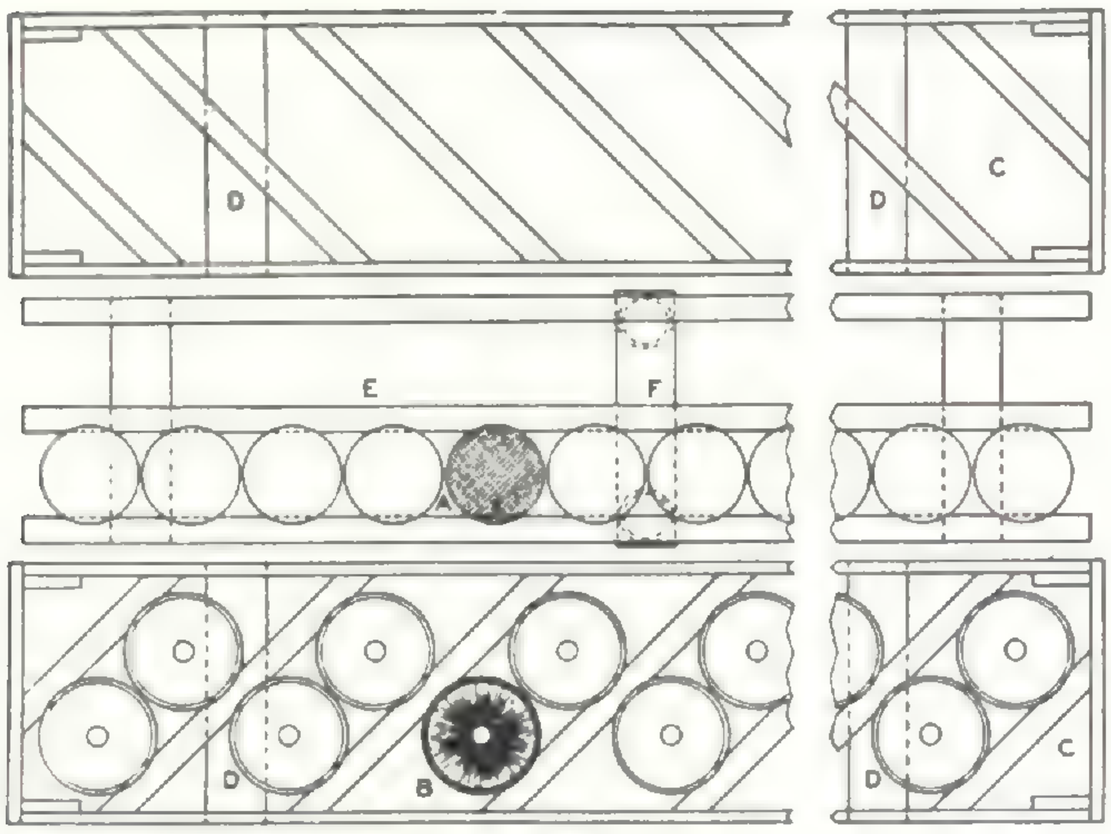
With plate 177 and one text figure

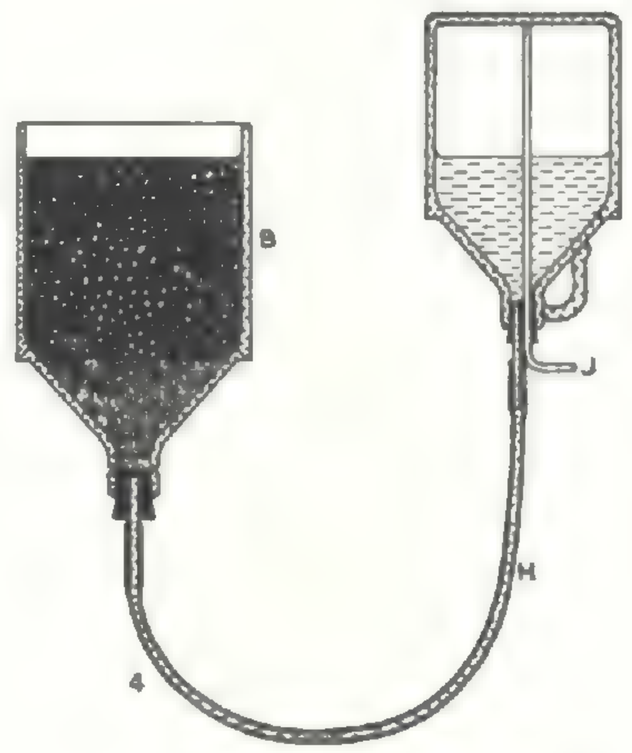
ONE of the essential requirements in nutritional studies on higher plants is a culture apparatus in which replications of an extended series may be studied simultaneously. It is also always desirable, if not actually necessary, that the time expended in the routine operations of watering and feeding the plants be reduced to a minimum. The most important consideration, however, from the physiological point of view is that the component parts of the apparatus with which the plants, medium, or nutrient come in contact be constructed of materials which are chemically resistant, as well as non-porous, and capable of affording leak-proof connections.

An apparatus which seems to satisfy these requirements better than any heretofore described has been designed and put into use by the writer in a study on physiological disorders of apple trees.

The apparatus consists primarily of an inverted, bottomless, one-gallon jug connected to an inverted, standard, one-half-gallon jug by means of rubber- and glass-tubing (Fig. 1[4]). The bottomless jug B, in which the plants are grown in white silica sand, is of standard dimensions but lacks both bottom and handle and has the neck grooved so that the rubber stopper may be wired in position. It is glazed externally according to standard requirements with a white glaze and internally with a special acid-resistant glaze. The sand found satisfactory for apple culture is a mixture of 5 parts of Columbia No. 4, a coarse, angular, silica sand, and 6 parts of Ottawa No. 20, a silica sand having almost spherical grains. The lower part of the jug, as shown in the illustration, is provided with the Columbia No. 4 sand to ensure good drainage. The sand is prevented from entering the glass tubing by the use of a small circle of Monel metal screening, No. 32 mesh, laid against the rubber stopper. The nutrient solution is placed in the one-half-gallon jug A, from which it is flooded into the sand by elevating this jug to the proper height and into which it is later drained by lowering again. The connecting tubings H are of heavy-walled gum rubber and standard Pyrex glass. As much of the latter is used as is conveniently possible (Plate 177). The tubing J, which facilitates movement of air in the nutrient jug, may also serve as a suction tube to which a very weak suction pump may be attached

if more aëration of the sand culture medium is desired than can be obtained by normal drainage of the nutrient solution. As many of these pieces of apparatus as are necessary or can be used conveniently are assembled on a wooden stand, as shown in Fig. 1, in which the culture jugs B...B are placed in twin beds C, C and the nutrient jugs A...A in a movable rack E. The writer was thus enabled to set up twenty-four cultures in triplicate, seventy-two cultures in all, on one greenhouse bench.





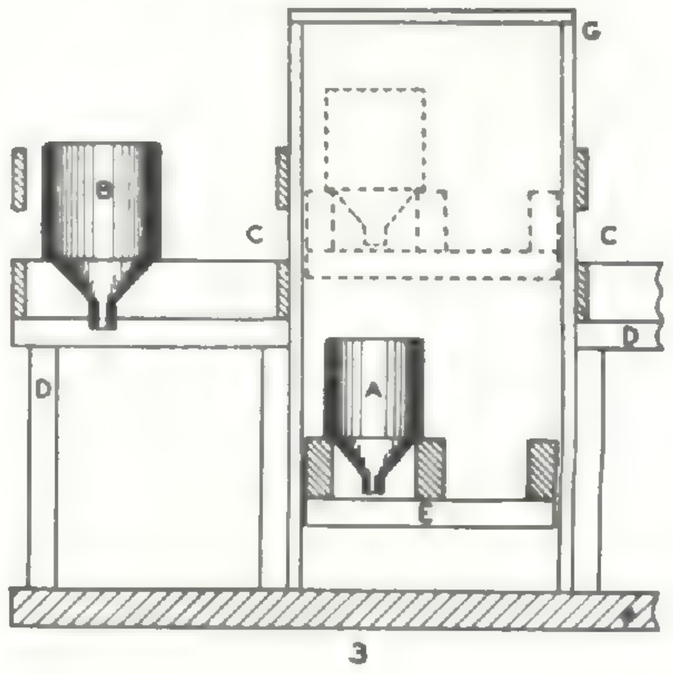


FIGURE 1. SAND CULTURE APPARATUS. 1, 2, 3. Working drawings of stand and assembled jugs. 4. Vertical section of jugs in flooding position.

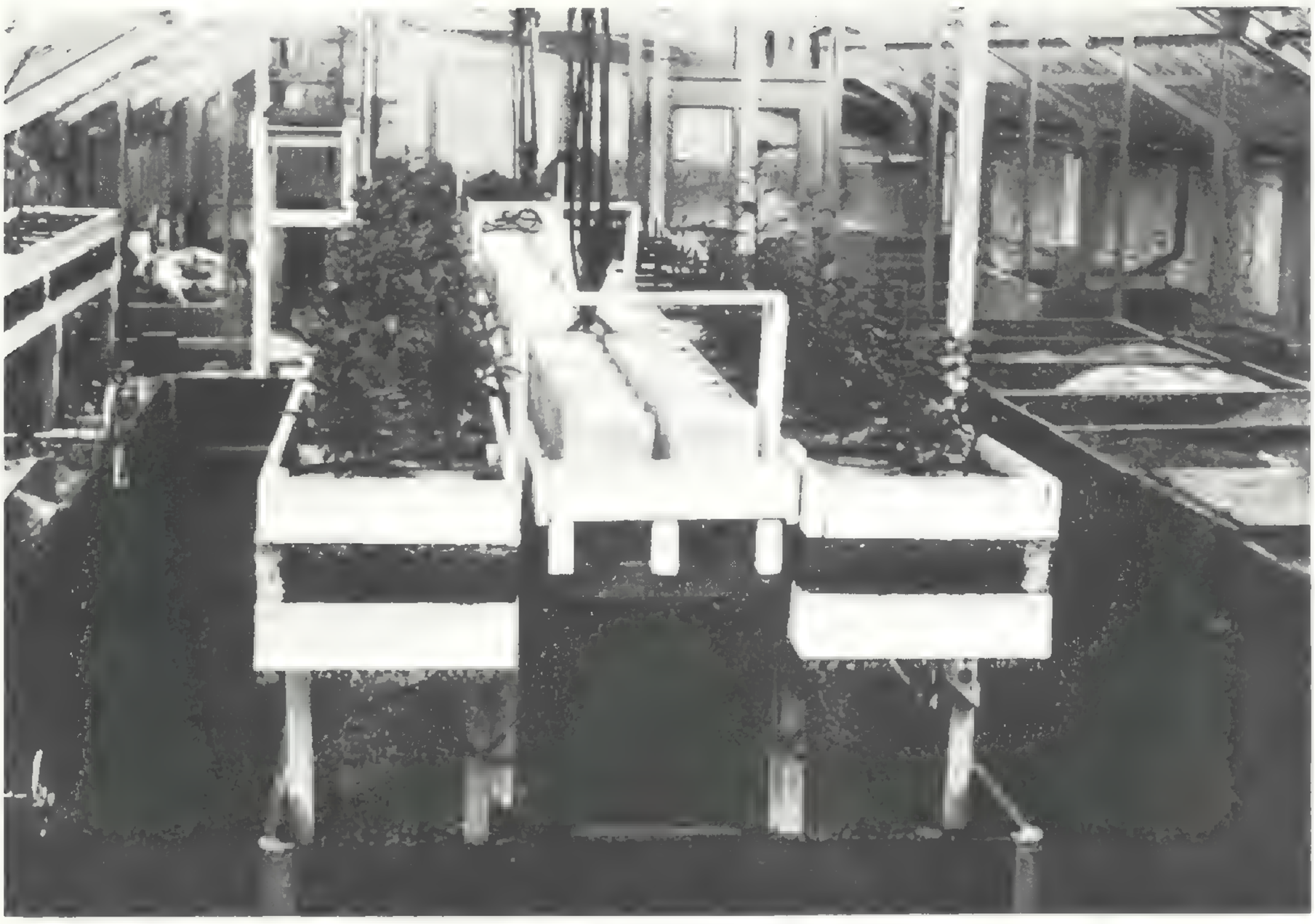
The wooden stand which holds the jugs has been designed to fit on an ordinary greenhouse bench (Fig. 1[1,2,3]; Plate 177). It is composed of twin beds C, C resting on horses D...D, placed about four feet apart, and a movable median rack E, which, in the raised or flooding position, rests on removable horses of a predetermined height, placed about eight feet apart (Plate 177) and which later, in the lowered or draining position, comes to rest on two stout spiral-spring blocks (Fig. 1[1,2,F]). The beds are fastened firmly to their respective horses and the ensemble is made immovable by use of the upright structures G...G (Fig. 1[3]; Plate 177), which also serve as guides for the rack E. The lumber used

in the construction of the stand is "western fir," 2 inches by 4 inches, and white pine, 1 inch by 4 inches. All exposed parts are painted with a good white waterproof paint.

Although details of construction of the stand are obvious in the accompanying working drawings (Fig. 1) there are several important features to be noted. First, the scantlings supporting the inverted bottomless jugs B...B in the beds C, C are mitered instead of being inserted at right angles or parallel to the sides of the bed. This makes it possible to adjust the beds to the proper width so that the ensemble of beds and rack may be accommodated on the greenhouse bench. The mitered angle of the scantlings depends naturally on the width of bed desired. The scantlings are also spaced accurately, both in the beds and rack, so that the inverted jugs may rest snugly on their shoulders between adjacent pieces. Secondly, an intermediate portion of the upright part of the beds and the entire bottoms are covered with galvanized wire netting of a coarse mesh. This permits the bottomless jugs in the beds to be packed in wet sphagnum moss, an arrangement which tends to keep the cultures at a uniform temperature due to the regulatory properties of evaporating water. Thirdly, the horses D...D supporting the beds must be of sufficient height to allow proper and adequate drainage of the cultures. Finally, it is imperative that at least two sets of heavy spiral springs F...F, of the shock-absorber type be placed in such a position under the rack E as to give the latter maximum support when fully loaded. This precaution is necessary to prevent shock and probable damage to the glass tubing when the rack with its heavy load of nutrient jugs and attached glass- and rubber-tubings are lowered to the draining position.

The operations of raising and lowering the rack and nutrient jugs are accomplished by means of two quadruple, self-locking block and tackle sets. These are attached to the rack at the proper supporting points and to a solid superstructure directly above the rack, the slings in each case being of Manila rope or some equally reliable material. The single operation of raising or lowering the rack can be accomplished by one operator and occupies about three minutes.

The height to which the rack should be raised for proper flooding of the cultures is determined in the following manner. Two liters of water are placed in the nutrient jug A, which is then set in the rack and connected to its respective culture jug B by means of the rubber- and glass-tubing H described above. The rack is then raised until the water level reaches exactly to the surface of the sand (Fig. 1[4]). This height is carefully recorded and light-weight wooden horses are constructed to support the rack when raised to this position (Plate 177).



SAND CULTURE APPARATUS WITH APPLE TREES IN CULTURE.

(Photos by A. B. Hatch)

At this time tests are made with several of the units to determine the average volume of water retained in the sand after drainage. Later, when the culture solutions are made up, this volume is taken into consideration.

The routine daily care of the cultures resolves itself briefly into the following operations. The rack is raised to the flooding position and, after a lapse of a few minutes to allow adjustment of the liquid level, distilled water is added directly to the sand to compensate for loss by evaporation and transpiration, until the original level at the surface of the sand is reached. Thus the original volume of the culture solution is retained throughout the course of the experiment. When the cultures have been flooded for a sufficient length of time the rack is lowered, allowing the sand to be drained and aërated naturally at the same time.

For purposes of convenience, the writer placed a carboy of distilled water on a high stand at the rear of the beds. Leading from this, along either of the outer sides of the beds, were two lines of 12 mm. glass-tubing provided with several outlets (Plate 177). A short length of rubber-tubing was attached successively to these outlets and by this means the complement of distilled water was added to the cultures directly from the carboy.

The frequency with which the culture solutions should be renewed depends upon the technique of the operator and the plants in culture. Since all of the nutrients can be accounted for, either in the plants or in the solutions, it is possible to make periodic analyses of the latter and adjust the time of renewal according to the interpretation of the results obtained.

This apparatus was designed and constructed in the laboratory of Professor J. H. Faull of the Arnold Arboretum, Harvard University, in connection with investigations carried on under his direction. This research was made possible through scholarships from the Harvard Forest and the Arnold Arboretum. The writer wishes to express his sincere thanks to Professor Faull for the facilities afforded and his continued interest. Much credit is due Professor P. R. Gast of the Harvard Forest, who contributed the basic principle of the apparatus devised from his own researches and assisted in many ways with time and equipment. Grateful appreciation is expressed to my former laboratory associates, Drs. A. B. Hatch and J. D. MacLachlan for their many constructive criticisms.

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CHROMOSOME COMPLEX AT PREMEIOTIC ANAPHASE AND MEIOTIC METAPHASE

HAIG DERMEN

With two text figures

A NUMBER of workers have reported in the case of plants that the individual chromosomes at anaphase are at least double. In this laboratory we have seen this duality in the root-tips (Dermen 1933), during all stages of microsporogenesis in *Rhoeo*, and in the telophase stage of embryo sac tetrad nuclei in *Lilium regale*. In the present paper we are presenting conclusive evidence indicating that this duality also exists in

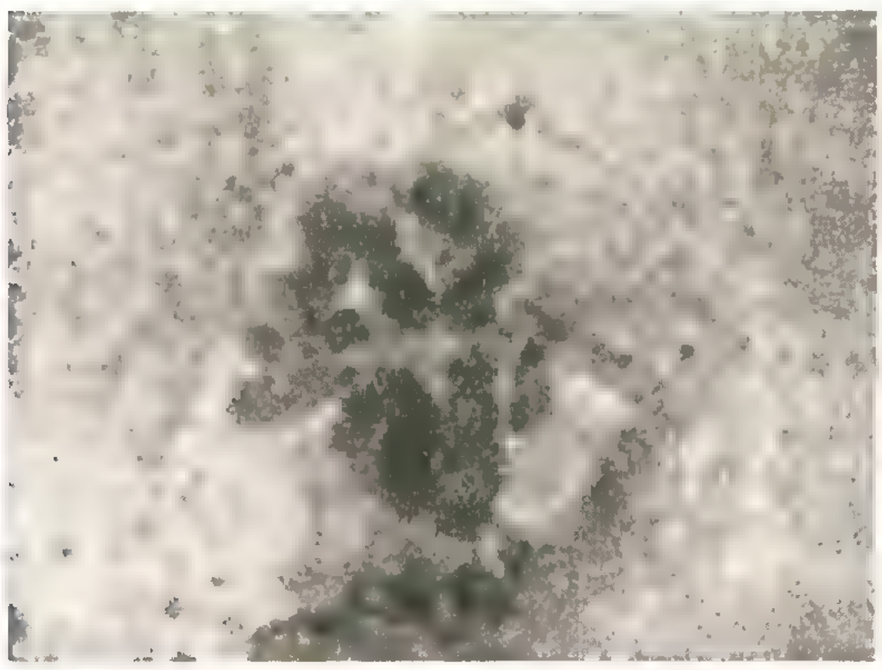

FIG. 1.

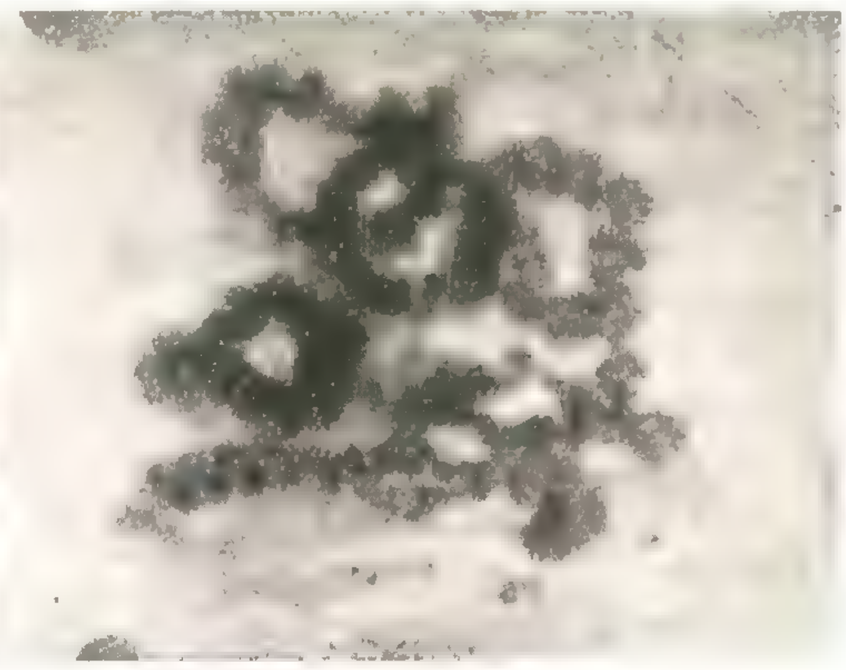

FIG. 2.

FIGURE 1. PREMEIOTIC ANAPHASE FROM RHOEO DISCOLOR.—FIGURE 2. MEIOTIC FIRST METAPHASE FROM A HYBRID TRADESCANTIA (T. REFLEXA X T. PALUDOSA).

the last premeiotic anaphase chromosomes which are destined to become meiotic leptotene threads. In addition to this the meiotic metaphase chromosomes were studied and were found to be structurally eight-parted.

The anthers of a young bud which is the third in series from that in the reduction stage in *Rhoeo discolor* were used for the study of premeiotic anaphase (Fig. 1). The cells of these anthers are for the most part in early prophase of meiosis but a few may be found in somatic metaphase or anaphase stage. The material showing the structure of meiotic first metaphase chromosomes (Fig. 2) was from a hybrid *Tradescantia, T. reflexa* × *T. paludosa*.

MATERIAL AND TECHNIQUE

The anthers in either case were smeared and pretreated for 5 to 10 seconds in 30% alcohol, 40 cc. in a staining jar, to which was added approximately 4 to 6 drops of ammonia water (26%), and the smear was then flooded with aceto-carmine 2 or 3 times for about 30 seconds. The slide was drained, any residual anther material that remained on the slide was removed, and a drop of aceto-carmine was added and a cover glass placed on the smear. The material was first located and studied, and if the preparation was successful the slide was gently heated over an alcohol lamp until small bubbles began to form. The cover glass was then pressed using a piece of filter paper for the purpose. To make these temporary preparations permanent either McClintock's acetic-alcohol or Metz's acetic-alcohol-xylol method may be used.

For a more permanent smear using the crystal violet-iodine stain, the following method is prescribed: Smear and pretreat as described above and place the slide, smear side down, in a small shallow dish containing a few drops of ½ to ¾ strength Flemming's modified solution for ½ to 1 minute. Rinse in water in a staining jar for one to two minutes, then stain in crystal violet for 15 seconds or longer depending upon the source of the material. Some plant smears may require over one minute of staining. If material so stained is thoroughly washed with xylol future destaining is prevented and the stain is as permanent as haemotoxylin preparations.

DESCRIPTION

A photomicrograph of an anaphase genom at last premeiotic stage from *Rhoeo discolor* is shown in figure 1. It is one of the two anaphase groups seen from a slightly oblique polar view. It shows on the lower right the short arm of a chromosome pointing down. From this position the structure of this arm could be clearly made out indicating unmistakably that it is split. The halves seem to be independently coiled and are not intimately associated. Where these chromosomes are twisted they appear as if constricted.

A meiotic first metaphase from a hybrid *Tradescantia* (*T. reflexa* × *T. paludosa*) is shown in figure 2, also a photomicrograph. A bivalent chromosome is seen in a horizontal plane. This pair of chromosomes at the connection point shows two kinds of split, one major and one minor. This type of opening was not confined to the rod-bivalents alone. In other cells in the ring-bivalent chromosomes at both ends of their connections, these double, large and small, diamond shaped openings could be observed, but for the purpose of illustration the rod-bivalent type was found best, for it is easily flattened out by pressure on the cover glass to show this feature.

DISCUSSION

The duality in the premeiotic chromosomes has been shown by Kaufmann (1926) in plant material. In animals, McClung (1928) and Robertson (1931) have demonstrated this duality of chromosomes at a corresponding stage. Koshy (1934) has illustrated the duality of premeiotic anaphase chromosomes and leptotene threads, though it appears from his drawings that he may have confused leptotene with pachytene stage.

Nebel (1932 and 1933), Stebbins (1935) and Goodspeed, Uber and Avery (1935) are in agreement that telophase chromosomes are four-parted. It is indicated that the leptotene threads, although optically single, are actually four-parted. Goodspeed et al. believe further, by estimation, that the meiotic metaphase chromosomes are sixteen-parted, thus homologizing with Drosophila salivary chromosomes which are suggested to be sixteen-parted.

Huskins (1932) and Huskins and Smith (1934 and 1935) have admitted the duality of anaphase chromosomes elsewhere but deny it in the premeiotic anaphase. They also have reported eight-parted meiotic metaphase chromosomes. Darlington (1935) on the other hand has denied the duality of anaphase chromosomes in all regions. He believes that anaphase chromosomes are single in both somatic and premeiotic phases because of the fact that leptotene threads appear to be single.

Our own evidence (Figs. 1 and 2) shows conclusively that premeiotic anaphase chromosomes are at least two-parted and eight-parted at meiotic metaphase. The indication is that mitotic and meiotic phases are essentially of the same fundamental nature, with this difference, that instead of each chromosome remaining as a unit and perpetually dividing as in mitosis, in meiosis similar chromosomes (homologues) pair together (barring the crossing-over phenomenon from the discussion) and during the first metaphase move to opposite poles. In mitosis homologues do not form intimate association while in meiosis their association is quite intimate and complex. The mitotic chromosomes are four-parted at metaphase, in meiosis they are eight-parted in the bivalents, and correspondingly there are four in each half of the bivalents.

I tried to analyze the same situation of duality in Lilium ovules where as in any other plant there is usually only one cell that becomes meiotic. The preparations I made (sectioned material) were of a somewhat advanced stage. However, there is one obvious thing that should be considered here, that this meiotic cell is a product of a somatic cell division. Here one cell only becomes meiotic while its sister cell continues the somatic cycle. It is hard to imagine if the anaphase chromo-

somes in the somatic cell are split, as Huskins admits (1932), how the anaphase chromosomes of one such group become normally split while those in the opposite group remain unsplit to justify Huskins' assumption that leptotene threads are single by origin. In both sister cells chromosomes are either split or unsplit since these halves are supposedly mirror images of each other. If the chromosomes were single in this stage there should be two cells alike and both meiotic. However, there is normally only one such cell. The obvious conclusion is that if chromosomes are split in the somatic cells at anaphase elsewhere, they must be split here too and that undoubtedly late premeiotic anaphase chromosomes of the egg-mother-cell are of a dual nature.

SUMMARY

Conclusive evidence is presented showing that last premeiotic anaphase chromosomes in microsporogenesis are split and that metaphase chromosomes in pollen-mother-cells are optically eight-parted. It is argued that the same is true in the ovule.

A method which enabled us to bring out the coiled structure in meiotic chromosomes is described in some detail. This method involves pretreatment of smear preparations with ammonia in alcohol.

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BURRETIODENDRON, A NEW GENUS OF TILIACEAE

ALFRED REHDER

With plate 178

Burretiodendron, gen. nov.

Flores dioeci, 5-meri, in cymis axillaribus paucifloris bracteatis pedunculatis petiolo multo brevioribus dense stellato-pilosis interdum in apice ramulorum brevium in paniculam brevem congestis; flores masculi breviter pedicellati, basi bracteolis 2 late ovalibus vel 3 ellipticis obtusiusculis concavis quam sepala fere dimidio brevioribus extus dense stellato-pilosis glandulis interspersis, intus glabris ante anthesin alabastrum arcte includentibus instructi; sepala 5, libera, anguste elliptica, acuta, extus dense stellato-pilosis, intus glabra basi area oblonga elevata dense glanduligera trientem sepali aequante instructa; petala 5, libera, alba aestivatione contorta, sepalis paulo longiora, unguiculata, lamina late obovata, apice fere truncata et plus minusve erosula et ciliolata basi in unguem tenuem fere dimidiam laminam aequantem attenuata, margine ciliolata excepta glabra; stamina circiter 30, petalis triente breviora, filamentis filiformibus infra medium in phalanges 5 et basi in tubum connatis, antheris lineari-oblongis bilocularibus basifixis, loculis rima longitudinali dehiscentibus; rudimentum ovarii parvum tubo staminali inclusum ovoideum rostratum. Flores feminei non visi. Capsula oblonga, stipitata, 5-alata, septicide 5-cocca, alis capsulae papyraceis bilamellatim partitis, coccis verticaliter bialatis indehiscentibus monospermis; semen oblongo-obovatum, basin versus attenuatum, apice obtusum et chalaza ovali notata, parce albuminosum; embryo rectus, cotyledonibus foliaceis latis tenuibus plicatis radicula recta.—Arbor ramulis hornotinis dense pilis stellatis vestitis, annotinis glabris. Folia alterna, decidua, ovata vel late ovata, acuminata, basi cordata, palminervia nervis basalibus 5–7 et insuper utrinsecus nervis 4–5 angulo angusto a costa media divergentibus et ascendentibus, nervis lateralibus a costa media et a nervis basalibus divergentibus ad marginem ceterum integram in mucronem exeuntibus, utrinque pilis stellatis satis dense, in costa et venis densius vestita, costa nervisque supra fere planis subtus distincte elevatis et trabeculis reteque venularum prominulis conjunctis; petioli satis graciles, dense stellato-pilosi; stipulae caducae, vestigia tantum adsunt.

Species unica Chinae occidentalis incola.

Burretiodendron Esquirolii (Lévl.), comb. nov.

Pentace Esquirolii Léveillé in Fedde, Rep. Spec. Nov. **10**: 147 (1911); Fl. Kouy-Tchéou, 419 (1915). — Burret in Notizbl. Bot. Gart. Mus. Berlin, **9**: 620 (1926).

Eriolaena Esquirolii Léveillé, Fl. Kouy-Tchéou, 405 (1915).

Character generis.

Petiolus 2.5–5 cm. vel interdum ad 11 cm. longus; folii lamina 6–12 cm. longa et 4–8 cm. lata vel interdum ad 28 × 20 cm. magna. Inflorescentia pedunculo brevi incluso circiter 3 cm. longo; bracteae 7 mm. longae; flores circiter 2 cm. diam.; sepala circiter 10 mm. longa et 4 mm. lata; petala ungue 3 mm. longo incluso circiter 11–12 mm. longa, lamina circiter 7–8 mm. lata; stamina 7 mm. longa antheris 2 mm. longis; ovarii rudimentum 1 mm. longum. Capsulae 3–3.5 cm. longa et circiter 1.5 cm. lata, alis circiter 6 mm. latis; semina 8 mm. longa et 3–4 mm. lata.

DISTRIBUTION: Southeastern Yunnan and Kweichou.

CHINA. Kweichou: ouest de Lo-fou (Kouai-kou), *J. Cavaleri*, no. 2648, Nov. 1905, "arbre moyen, moucilagineux" (holotype of *Pentace Esquirolii;* photo. in A. A.); same locality, *J. Esquirol*, no. 817, and Yang-ly, *J. Esquirol*, no. 2717, both cited in Fl. Kouy-Tchéou under *P. Esquirolii;* Yang-ly, *J. Esquirol*, no. 2717, Aug. 1911, "arbre 8–10 métres, fleur blanche" (holotype of *Eriolaena Esquirolii;* photo. in A. A.); Lohu, 170 m. in lightly shaded ravine, *Y. Tsiang*, no. 7290, Oct. 3, 1930, "tree 10 m. high, diam. of trunk (breast high) 20 cm., leaves dull green above, light green below, fruit yellowish green" (New York Bot. Gard.). Yunnan: Red River, *A. Henry*, no. 9572 (New York Bot. Gard.); Red River, near Manhao, *A. Henry*, no. 9573, "tree 25 ft., flowers all fallen off, young green fruit" (New York Bot. Gard.).

This new genus does not seem to be closely related to any of the genera of the Tiliaceae or Sterculiaceae, but is best perhaps placed in the Tiliaceae near *Luehea;* from the Sterculiaceae it differs in the dry winged fruit dividing septicidally into one-seeded carpels broadly winged all around, and in the androecium which in the latter family has the episepalous stamens sterile or lacking, while in *Burretiodendron* they are all fertile. With *Luehea* it agrees in the lack of an androgynophore and in pentadelphous stamens, but differs markedly in the unisexual flowers, in the slender-clawed petals without glandular spot at the base and in the fruit separating into 5 one-seeded carpels. In the presence of a nectary at the base of the sepals *Burretiodendron* differs from all Tiliaceae. In the fruit separating into one-seeded winged carpels, it resembles *Colona*, but is easily distinguished by the unisexual flowers in axillary short cymes, the lack of an androgynophore, the clawed petals

Burretiodendron
Esquirolii (Lévl.) Rehd
gen. et comb. nov.
Det. Alfred Rehder
Arnold Arboretum 5. XII. 1935

BURRETIODENDRON ESQUIROLII (Lévl.) Rehder.

without nectary and the pentadelphous stamens. *Eriolaena* in which Lé veillé placed the flowering specimen, differs among other characters chiefly in its ligneous loculicidally dehiscent capsule with many winged seeds. *Pentace*, to which he referred the fruiting specimen, is easily distinguished by the rather small bisexual flowers in large terminal panicles and the much smaller indehiscent one-seeded fruit.

The specimens collected by Henry near Manhao, about 25 kilometers north of the border of Tonkin, agree exactly with Cavalerie's and Esquirol's specimens, except that the former have the leaves generally more deeply cordate like those of Tsiang's specimen. The genus may possibly extend into northern Tonkin and northwestern Kwangsi.

I take pleasure in naming this new and very distinct genus in honor of Dr. M. Burret who has made important contributions to the knowledge of the Tiliaceae.

EXPLANATION OF PLATE 178

Fig. 1. Fruiting specimen, Y. Tsiang, no. 7290. × 2/5.
Fig. 2. Single carpel of fruit from the ventral and dorsal side. × 2/5.
Fig. 3. Axillary cyme with one open flower, from Henry, no. 9572. Natural size.
Fig. 4. Terminal panicle of flower buds, from Henry, no. 9572. Natural size.

HERBARIUM, ARNOLD ARBORETUM,
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TWO NEW SPECIES OF GYMNOSPORANGIUM FROM ASIA

IVAN H. CROWELL

With two text figures

Gymnosporangium magnum Crowell, sp. nov. (Fig. 1).

Spermogonia foliicolae, subepidermalia. Aecidia hypophylla, cupuliformia, tumoribus subglobosis insidentia; cellulae peridii rhomboideae, hyalinae, pariete interiore marginibusque subspinulosae, 22.5–30.6 × 50.0–64.4 μ, plus minusve 24.3 × 59.2 μ; aecidiosporae globosae, pallide brunneae, verruculosae, 24.2–29.0 × 30–32 μ, plus minusve 26.1 × 29.8 μ.

FIG. 1.

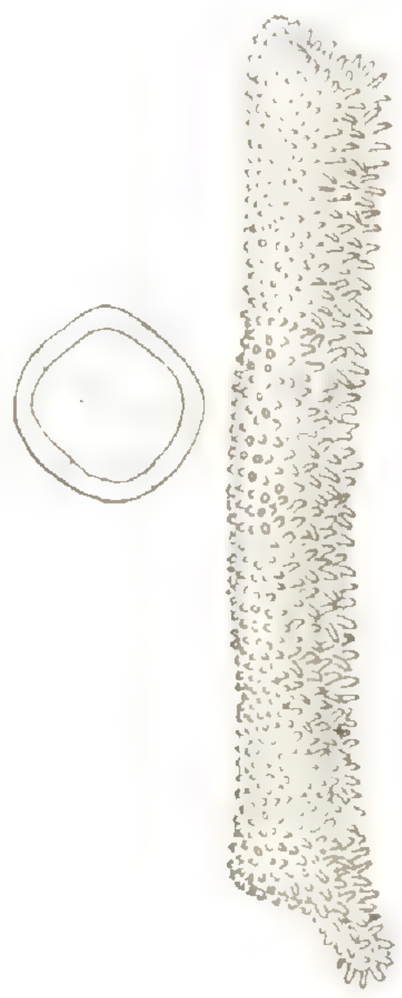

FIG. 2.

FIGURE 1. GYMNOSPORANGIUM MAGNUM Crowell.—FIGURE 2. GYMNOSPORANGIUM LEVE Crowell.—AECIOSPORES AND PERIDIAL CELLS.

Hab. in foliis *Crataegi sp.* in China centrali. Ex Herb. G. Lagerheim, Botaniska Andelning Riksmuseet, Stockholm, Sweden (Smith, no. 917).

The specific name is suggested by the unusual size of the aeciospores, a feature in which they are surpassed by *G. juniperinum* (L.) Mart. only.

Gymnosporangium leve Crowell, sp. nov. (Fig. 2).

Spermogonia foliicolae, subepidermalia. Aecidia hypophylla, roestelioidea, tumoribus tumidis insidentia, 1–2 mm. alta, 0.25–0.5 mm. lata; cellulae peridii elongatae, hyalinae, pariete interiore spinulosae, mar-

ginibus et pariete exteriore gradatim plus breviter spinulosae, 12.8–18.2 × 80–120 μ, plus minusve 15.2 × 102 μ; aecidiosporae globosae, pallide brunneae, leves, 19.2–22.4 × 20.8–24.0 μ, plus minusve 20.8 × 22.6 μ.

Hab. in foliis *Mali Sieboldii* (Reg.) Rehd. in China. Ex Herb. G. Lagerheim, Botaniska Andelning Riksmuseet, Stockholm, Sweden (Smith, no. 4221).

The material from which this species is described was collected by Smith at Karlong, Szechuan, China, altitude 3200 m., Aug. 27, 1922. The specific name is suggested by the smooth surface of the aeciospore wall, a character of rare occurrence in this genus of rusts.

Comparatively few species of *Gymnosporangium* have so far been described from Asia. One feature common to them, generally speaking, is the occurrence of spinulose embossments on the peridial cells of the aecia. Among the American species this feature is found in *G. exiguum* Kern only.

The specimens which now become the types of *Gymnosporangium magnum* and *G. leve* were loaned from the Herbarium of the Naturhistorika Riksmuseet, Stockholm, Sweden, through the courtesy of Professor Dr. Gunnar Samuelsson.

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NOTES ON THE LIGNEOUS PLANTS DESCRIBED BY H. LEVEILLE FROM EASTERN ASIA[1]

ALFRED REHDER

IN THE COURSE of my revision of the ligneous plants described by Léveillé from Eastern Asia, it became apparent that after once going over the ground in systematic order, I would have to publish a supplement to include those plants which for various reasons, had been omitted in the first account.

When I started this work in 1929, after a short sojourn in Edinburgh in the summer of the preceding year, I based it chiefly on notes and photographs I had taken and on duplicates of types generously given to me whenever feasible, by Sir William Wright Smith, Regius Keeper of the Royal Botanic Garden. Later in the course of my work, Sir William kindly offered to send me on loan all the types I had not examined while in Edinburgh; this enabled me to treat the later families more fully. Another reason for the omission of certain species in their proper places was the fact that in many instances, species referred by Léveillé to certain genera, did not belong there but to families previously treated, e.g. *Clerodendron Esquirolii* which turned out to be a *Tacca*. There remains also to be cited important additional literature dealing with Léveillé's plants and not yet mentioned in my previous publications.

After having finished my first attempt of an enumeration of Léveillé's ligneous plants in systematic order from the Taxaceae to the Compositae, I journeyed last year once more to Edinburgh to go over the Léveillé herbarium, and again Sir William facilitated my work in every possible way, so that I was able to accomplish much in the limited time at my disposal.

It is to be expected that with the following supplement, the critical enumeration of the ligneous species described by Léveillé from eastern Asia will be fairly complete with the exception, perhaps, of a few species which could not be located in Léveillé's herbarium.

[1]Continued from Vol. **16**: 311–340; for preceding parts see Vols. **10**: 108–132, 164–196; **12**: 275–281; **13**: 299–332; **14**: 223–252; **15**: 1–27, 89–117, 267–326.

TAXACEAE[1]

Podocarpus neriifolius D. Donn. — Rehder in Jour. Arnold Arb. **10:** 108 (1929).

Alyxia Schlechteri Léveillé, Fl. Kouy-Tchéou, 30 (1914), quoad Cavalerie, no. 3463; not Léveillé (1911).

CHINA. K w e i c h o u : Lo-fou, rivière de l'ouest, *J. Cavalerie*, no. 3463, March 1909, "petit arbre, 4–5 m." (sub *Alyxia Schlechteri* in herb. Lévl.; duplicate in A. A.).

Leaves of Cavalerie no. 3463 were sent in 1916 to the Arnold Arboretum by Léveillé in answer to our request for a fragment of *Alyxia Schlechteri*. For typical *A. Schlechteri* see Jour. Arnold Arb. **15:** 316 (1934).

Of *P. macrophylla* var. *Argyi* Léveillé in Mem. R. Acad. Ci. Barcelona, ser. 3, **12:** 547 (1916), nom. nud., I have seen no description and no specimen; it is probably not different from *P. macrophylla*.

Taxus chinensis (Pilger) Rehder in Jour. Arnold Arb. **1:** 51 (1919).

Tsuga Mairei Lemée & Léveillé in Monde Pl. ser. 2, **16:** 20 (1914). — Léveillé, Cat. Pl. Yun-Nan, 58 (1916). — **Synon. nov.**

CHINA. Y u n n a n : commun sur les collines du nord, 700–800 m., *E. E. Maire*, May, 1912 (holotype of *Tsuga Mairei;* photo. and merotype in A. A.).

The type specimen is sterile. To *T. chinensis* probably also belongs *T. cuspidata* in Léveillé, Fl. Kouy-Tchéou, 112 (1914).

PINACEAE[2]

Pinus Massoniana Lambert. — Rehder in Jour. Arnold Arb. **10:** 109 (1929).

Pinus Argyi Lemée & Léveillé in Fedde, Rep. Spec. Nov. **8:** 60 (1910). — Léveillé in Mem. R. Acad. Ci. Barcelona, ser. 3, **12:** 547 (Cat. Pl. Kiang-Sou, 7) (1916).

Pinus Argyi var. *longevaginans* Léveillé in Fedde, l.c. and Mem. l.c.

Pinus Cavaleriei Lemée et Léveillé in Fedde, l.c.

Pinus tabulaeformis Carr. sensu Rehder in Jour. Arnold Arb. **10:** 109 (1929) quoad syn. *P. Argyi;* non Hort. ex Carrière.

CHINA. K i a n g s u : Che-sang and Zuosé, *Ch. d'Argy* (syntypes of *P. Argyi;* photos. in A. A.); locality illegible, *Ch. d'Argy* (holotype of *P. Argyi* var. *longevaginans;* photo. in A. A.). K w e i c h o u : Pin-fa, montagnes, *J. Cavalerie*, no. 1695, March 22, 1902 (holotype of *P. Cavaleriei;* photo. in A. A.).

[1]See Vol. **10:** 108.
[2]See Vol. **10:** 108.

When I enumerated Léveillé's species cited above in 1929, I had not seen any of the type specimens. I have since had the opportunity to examine the types, and find that they all belong to *P. Massoniana* and bore already on the sheets identification labels, two (*P. Cavaleriei* and *P. Argyi* var. *longevaginans*) by V. Komarov, and the other two signed by M. Y. O[rr].

Cunninghamia lanceolata (Lamb.) Hooker in Bot. Mag. **54**: t. 2743 (1827).

Cunninghamia sinensis var. *prolifera* Lemée & Léveillé in Monde Pl. ser. 2, **16**: 20 (1914). — Léveillé, Cat. Pl. Yun-Nan, 56 (1916).

China. Yunnan: Tong-tchouan, pagode, alt. 2500 m., *E. E. Maire,* March [1910–13] "rameaux secondaires pendants, naissant tous du centre d'un fruit" (holotype of *C. sinensis* var. *prolifera;* photo. in A. A.).

The abnormality that the axis of the cone continues growing into a leafy branch is found occasionally in this species, e.g. in Wilson's no. 4076 from Szechuan. It can hardly be considered a variety; at best it is a monstrous form.

Cryptomeria japonica (L.f.) D. Don in Trans. Linn. Soc. **18**: 166, t. 13, fig. 1 (1841). — Léveillé, Fl. Kouy-Tchéou, 111 (1914); Cat. Pl. Yun-Nan, 56 (1916).

Cupressus Mairei Léveillé, Cat. Pl. Yun-Nan, 56 (1916). —**Synon. nov.**

Cupressus Duclouxiana Hickel sensu Rehder in Jour. Arnold Arb. **10**: 110 (1929), quoad syn. *Cupressus Mairei;* non Hickel.

China. Yunnan: plaine de Tong-tchouan, pagodes, alt. 2500 m., *E. E. Maire,* Jan. [1910–13], "grand et superbe resineux, petits rameaux decourbants." (holotype of *Cupressus Mairei;* photo. and merotype in A. A.).

In 1910 when I referred *Cupressus Mairei* doubtfully to *C. Duclouxiana* Hickel, I had not seen the type specimen.

Thuja orientalis Linnaeus, Sp. Pl. 1002 (1753). — Léveillé, Fl. Kouy-Tchéou, 112 (1914); Cat. Pl. Yun-Nan, 56 (1916).

Thuja orientalis L. var. *Argyi* Léveillé & Lemée in Monde Pl. ser. 2, **17**: 15 (1915).

China. Kiangsu: *Ch. d'Argy,* [1848–66] (holotype of *Th. orientalis* var. *Argyi;* photo. and merotype in A. A.).

The specimen which bears staminate flowers differs slightly from the usual form in its more slender and distant branchlets, but the differences are hardly sufficient to distinguish it as a variety or form.

Juniperus squamata Lambert, Descr. Gen. Pinus, **2**: 17 (1824). — Rehder & Wilson in Jour. Arnold Arb. **9**: 17 (1928). — Handel-Mazzetti, Symb. Sin. **7**: 8 (1929).

Juniperus Franchetiana Léveillé, Cat. Pl. Yun-Nan, 57 (1916), nom. seminud. — Komarov in Not. Syst. Herb. Hort. Bot. Reipub. Ross. **5**: 30 (1924), cum descript.

CHINA. Yunnan: au dessus du col de Yentzchay, *J. Delavay*, no. 3112, July 19, 1887 "arbrisseau à tiges redressées" (ex Komarov; syntype in herb. Paris, photo. in A. A.).

Juniperus Franchetiana, of which the type could not be located in the Léveillé herbarium is known to me only from a photograph of a Delavay specimen in the Paris herbarium. Komarov distinguishes it from *J. Fargesii* and from *J. squamata* chiefly by its fruit and seed characters, while Handel-Mazzetti l.c. places it under *J. squamata*.

Juniperus Franchetiana is based by Léveillé on *J. recurva* Franchet, non Hamilton, which in Plantae Wilsonianae (**2**: 58. 1914) was cited as a synonym of *J. squamata*. Franchet (Pl. David. **1**: 292. 1884) cites under *J. recurva* a specimen collected in Shensi without any further remarks; the type of *J. recurva* Franchet, non Hamilton, and consequently the type of *J. Franchetiana*, would therefore be the David specimen from Shensi and not Delavay's specimen from Yunnan.

Juniperus squamata Lamb. var. **Fargesii** (Komar.) Rehder & Wilson in Sargent, Pl. Wilson. **2**: 59 (1914).

Juniperus Fargesii Komarov in sched. Herb. Paris, Feb. 1911; in Not. Syst. Herb. Hort. Bot. Reipub. Ross. **5**: 30 (1924), cum descript.

Juniperus Lemeeana Léveillé & Blin in Léveillé, Fl. Kouy-Tchéou, 111 (1914). — Handel-Mazzetti, Symb. Sin. **7**: 7 (1929).

CHINA. Kweichou: Gan-chouen, *J. Cavalerie*, no. 3922 (holotype of *J. Lemeeana*; photo. in A. A.).

By Komarov and by Handel-Mazzetti this juniper is considered a distinct species, but it seems closely connected with *J. squamata* by intermediate forms, and I prefer to keep it, at least for the present, as a variety of the latter. If considered a distinct species, the correct name will be *J. Lemeeana* Lévl. & Blin which has priority.

GNETACEAE

Gnetum Cavaleriei Léveillé, Fl. Kouy-Tchéou, 186 (1914). — Markgraf in Engler & Prantl, Nat. Pflanzenfam. ed. 2, **13**: 440 (1926).

CHINA. Kweichou: Pin-fa, sur un arbre au sud à Pai-tchen, *J. Cavalerie*, no. 2336, March 30, 1905 (holotype; merotype in A. A.).

The specimen is fragmentary; it consists of bare branches and broken,

immature, catkin-like inflorescences covered with a ferrugineous woolly tomentum. By Markgraf (in Bull. Jard. Buitenzorg, ser. 3, **10:** 490. 1930) it was referred to *Populus*, but it certainly does not belong to that genus. From a certain resemblance of the branches and the pubescence to *Lannea*, I thought it might belong to the Anacardiaceae, and Dr. I. W. Bailey who kindly examined the wood structure, made the following statement: "The plant has five traces and five gaps at each node and the wood is clearly ring porous. The various anatomical characters, as a whole, would appear to place the plant in either the Anacardiaceae or the Burseraceae. I should be inclined to place it in the Anacardiaceae except for the fact that this family is stated to have trilacunar nodes. The Burseraceae have five traces, but I know of no species which is ring porous. The transition from three to five traces is an easy one and it may be that certain Anacardiaceae have five traces."

To the Gnetaceae Léveillé (l.c.) doubtfully refers Cavalerie no. 2764 from Pin-fa, Li-tséou-gai, April 1906, "grand arbre à tronc ècailleux, les rameaux coupés laissent couler une sorte de colle." The specimen consists of branches with long pendulous staminate catkins which slightly resemble the spikes of *Gnetum*. It belongs to *Carpinus* and is probably referable to *C. Fangiana* Hu with which it agrees in the large winter-buds with strongly striate scales.

ARACEAE

Rhaphidophora Dunniana Léveillé in Fedde, Rep. Spec. Nov. **9:** 325 (1911); Fl. Kouy-Tchéou, 39 (1914).

China. Kweichou: Kuao-siang, lieux ombreux et frais, forêts profonds et ruisseaux, *J. Esquirol*, no. 246, Jan. 1905, "gros lierre qui monte aux arbres et rochers" (holotype; photo. in A. A.).

The specimen consists only of some bare branches, an immature inflorescence and detached leaves which measure 8–15 × 5–9.5 cm. and are abruptly contracted into a short acumen about 5 mm. long. It is similar to *Rh. Calophyllum* Schott from Khasia and Sikkim, but may possibly belong to *Scindapsus*.

STEMONACEAE

Stemona japonica (Bl.) Miquel, Prol. Fl. Jap. 386 (1867).

Helwingia Argyi Léveillé & Vaniot in Bull. Herb. Boissier, ser. 2, **6:** 506 (1906).

Stemona Argyi (Lévl. & Vant.) Léveillé in Fedde, Rep. Spec. Nov. **10:** 441 (1912); in Mem. Acad. Ci. Barcelona, ser. 3, **12:** 560 (Cat. Pl. Kiang-sou, 20) (1916). — **Synon. nov.**

CHINA. Kiangsu: Sou-tchéou-fou, *Ch. d'Argy* [1848–66] (syntype of *Helwingia Argyi;* merotype in A. A.). Anhwei: Ning-koue-fou, *Ch. d'Argy* [1848–66] (syntype of *H. Argyi;* ex Léveillé).

Neither C. H. Wright (in Jour. Linn. Soc. Bot. **32**: 493. 1896), nor Schlechter (in Notizbl. Bot. Gard. Mus. Berlin, **9**: 193. 1924) credit *S. japonica* to China, but Hemsley (in Jour. Linn. Soc. Bot. **36**: 95. 1903) cites a specimen from Kiangsu collected by Carles (no. 357) on the hills near Shanghai.

The two specimens in the Léveillé herbarium are in a cover which bears on the outside the localities "Sou-tchéou Ning-koue-fou," but there is no indication from which locality each specimen came, nor any reference to Anhwei (Ngan-hoei).

LILIACEAE[1]

Smilax herbacea L. var. **acuminata** Wright in Jour. Linn. Soc. Bot. **36**: 97 (1903).

Smilax herbacea L. var. *foetida* Léveillé in Mem. Pontif. Accad. Nuov. Lincei, **23**: 351 (Liliac. 23) (1905); Fl. Kouy-Tchéou, 256 (1914).

Smilax herbacea L. var. *heterophylla* Léveillé l.c. (1905).

CHINA. Kweichou: Pin-fa, bois, bords des torrents, lieux ombrageux, *J. Cavalerie,* no. 1314, May 25, 1902 (holotype of *S. herbacea* var. *foetida;* photo. in A. A.); same locality and collector, no. 1314, May 22, 1902 (holotype of *S. herbacea* var. *heterophylla;* photo. in A. A.).

Both of Léveillé's varieties cited above are referable to var. *acuminata* Wright with which they agree in the gradually acuminate leaves, but they differ widely in the width of their leaves, var. *heterophylla* having on one branch leaves about 8 cm. wide, on the other 2 cm. in width, while var. *foetida* is intermediate with about 3–4 cm. width.

Smilax glabra Roxburgh, Fl. Ind. ed. 2, **3**: 792 (1832). — Léveillé, Fl. Kouy-Tchéou, 256 (1914). — Rehder in Jour. Arnold Arb. **10**: 110 (1929). — Wang & Tang in Sinensia, **5**: 417 (1934).

Smilax glabra Roxb. var. *maculata* Bodinier ex Léveillé in Mem. Pontif. Accad. Nuov. Lincei, **23**: 351 (Liliac. 23) (1905).

Smilax Dunniana Léveillé in Fedde, Rep. Spec. Nov. **9**: 446 (1911).

Smilax Blinii Léveillé, Fl. Kouy-Tchéou, 256 (1914).

CHINA. Kweichou: Ma-jo, *J. Cavalerie,* no. 2973, July 1908 (holotype of *S. Dunniana* and *S. Blinii;* merotype in A. A.). Hong-

[1]See Vol. **10**: 110.

k o n g : dans les rocailles d'un torrent à mi-côte du Pic Victoria, *E. Bodinier*, Feb. 24, 1893 (holotype of *S. glabra* var. *maculata;* photo. in A. A.).

Smilax Dunniana is not cited in Flore du Kouy-Tchéou, but *S. Blinii* is described as a new species in that work, based on the same number. The name *S. Dunniana* does not appear on the type specimen in the Léveillé herbarium.

Smilax glabra var. *maculata* is hardly different enough to be maintained as a variety; it is at best a slight form. Specimens of *S. glabra* with leaves variegated with irregular white spots occasionally occur, e.g. T. N. Hsiung 494 from Kiangsi, J. B. Norton 1252 from Fukien and U. Faurie 950 from Formosa.

Smilax microphylla Wright in Kew Bull. **1895:** 117. — Wang & Tang in Sinensia, **5:** 418 (1934).

Smilax Labordei Léveillé & Vaniot in Mem. Pontif. Accad. Nuov. *Lincei,* **23:** 355 (Liliac. 27) (1905). — Léveillé, Fl. Kouy-Tchéou, 257 (1914).

Smilax gracillima Léveillé & Vaniot, l.c. 354 (Liliac. 26) (1905). — Léveillé, Fl. Kouy-Tchéou, 256 (1914).

Smilax Darrisii Léveillé in Fedde, Rep. Spec. Nov. **12:** 533 (1913); Fl. Kouy-Tchéou, 256 (1914). — Rehder in Jour. Arnold Arb. **10:** 111 (1929). — Wang & Tang in Sinensia, **5:** 419 (1934). —

Synon. nov.

Smilax Mairei Léveillé in Bull. Géog. Bot. **25:** 39 (1915); Cat. Pl. Yun-Nan, 169 (1916). — Rehder in Jour. Arnold Arb. **10:** 111 (1929).

China. K w e i c h o u : environs de Kouy-yang, mont. du Collège, rocailles, June 2, 1898 (flowers), environs de Tsin-gay, Dec. 9, 1897 (fruit), *J. Laborde* in herb. *Bodinier,* no. 2318 "petit buisson épineux" (holotype of *S. Labordei;* photo. in A. A.); Tsin-gay, bois, *J. Cavalerie,* no. 1156, July 15, 1903 (holotype of *S. gracillima,* photo. in A. A.); steppes et bois de Gan-chouen, *J. Cavalerie,* no. 3819, Dec. 1909, *J. Esquirol,* no. 3145, May, 1911 (syntypes of *S. Darrisii;* merotype of Cavalerie's and photo. of Esquirol's specimen in A. A.). Y u n n a n : rochers à mi-mont de La-kou, 2400 m., *E. E. Maire,* June 1912 (holotype of *S. Mairei;* photo. in A. A.).

Smilax Darrisii is enumerated as a distinct species by Wang & Tang (l.c.) as it was by me (l.c.), but I do not see now that it can be separated from *S. microphylla.* On the other hand, Wang & Tang refer *S. castaneiflora* Lévl. to *S. microphylla,* but that is undoubtedly a different species.

Smilax scobinicaulis Wright in Kew Bull. **1895**: 117.

Smilax brevipes Warburg in Bot. Jahrb. **28**: 256 (1900). — Wang & Tang in Sinensia, **5**: 419 (1934).

Smilax ocreata Léveillé & Vaniot apud Léveillé in Mem. Pontif. Accad. Nuov. Lincei, **23**: 354 (Liliac. 26) (1905). — Léveillé, Fl. Kouy-Tchéou, 257 (1914). — Non A. De Candolle (1878).

Smilax Martini Léveillé & Vaniot in Léveillé in Mem. Pontif. Accad. Nuov. Lincei, **23**: 355 (Liliac. 26) (1905). — Léveillé, Fl. Kouy-Tchéou, 257 (1914).

Smilax Cavaleriei Léveillé & Vaniot apud Léveillé in Mem. Pontif. Accad. Nuov. Lincei, **23**: 355 (Liliac. 27) (1905). — Léveillé, Fl. Kouy-Tchéou, 257 (1914); Cat. Pl. Yun-Nan, 168 (1916).

CHINA. K w e i c h o u : environs de Gan-pin, au Grandes Rocailles, traînant sur les rochers, *L. Martin* in herb. *Bodinier*, no. 1871, Sept. 17, 1897 (holotype of *S. ocreata;* photo. in A. A.); Pin-fa, bois, *J. Cavalerie*, no. 1315, May 3, 1902 (holotype of *S. Martini;* photo. in A. A.); Pin-fa, montagnes, *J. Cavalerie*, no. 1313, May 3, 1902 (holotype of *S. Cavaleriei;* photo. in A. A.).

The three species of Léveillé's had been referred by Wang & Tang to *S. brevipes* Warb. which can hardly be separated from *S. scobinicaulis* as a distinct species.

Smilax leucocarpa Léveillé & Vaniot apud Léveillé in Mem. Pontif. Accad. Nuov. Lincei **23**: 354 (Liliac. 26) (1905); **24**: 344 (Liliac. 10) (1906). — Wang & Tang in Sinensia, **5**: 420 (1934).

Smilax Esquirolii Léveillé, Fl. Kouy-Tchéou, 256 (1914).

CHINA. K w e i c h o u : environs de Kouy-yang, dans les bois de Kien-lin-chan, *E. Bodinier*, no. 2124, Apr. 14 (flowers) and July 7 (fruit), 1898, "arbuste épineux, à tiges dressées, non sarmenteuses" (holotype of *S. leucocarpa;* photo. in A. A.); plateau de San-tou, 1000 m., *J. Esquirol* no. 2109, May 1, 1910 (type of *S. Esquirolii;* photo. in A. A.); Gan-pin, *J. Cavalerie*, no. 2120 (op. cit. **24**: 344 under *S. leucocarpa;* photo. in A. A.).

This species resembles somewhat in its small leaves *S. microphylla* Wright, but the leaves are cuneate and obtuse and the fruits are yellow; from the related *S. megalantha* Wright and *S. China* L. it is at once distinguished by the very small obovate to obovate-oblong obtuse leaves and smaller fruits on shorter peduncles.

In the Flore du Kouy-Tchéou Léveillé cites *S. leucocarpa* as a synonym of *S. Esquirolii*, a name which appears on the sheet of Esquirol 2109, but does not seem to have been published before 1914.

Smilax megalantha Wright in Kew Bull. **1895**: 118. — Wang & Tang in Sinensia, **5**: 420 (1934).

Smilax loupouensis Léveillé in Bull. Géog. Bot. **25**: 38 (1915); Cat. Pl. Yun-Nan, 169 (1916).
Smilax ferox Wall. sensu Rehder in Jour. Arnold Arb. **10**: 110 (1929), p.p., quoad synon. *S. loupouensis;* non Wall. ex DeCandolle.

China. Yunnan: "brousse des mont. à Lou-pou, 3000 m., *E. E. Maire,* Sept. 1912, "arbuste grimpant, un peu épineux, feuilles blanches au dessous, fleurs grises" (holotype of *S. loupouensis;* merotype in A. A.).

Smilax loupouensis resembles *S. discotis* Warb. in its stipules extending the entire length of the short petiole, but that species has black fruits. From *S. ferox,* to which it seems closely related, it differs in the only slightly spiny branches, in the leaves being abruptly contracted at the apex and very glaucous beneath and in the stipules. It apparently agrees best with *S. megalantha,* but differs from the type in the shorter petioles with the stipules extending the whole length.

Smilax China Linnaeus, Spec. Pl. 1029 (1753). — Léveillé, Fl. Kouy-Tchéou, 256 (1914), p.p. excl. syn. *S. Bodinieri;* Cat. Pl. Yun-Nan, 168 (1916). — Norton in Sargent, Pl. Wilson. **3**: 4 (1916).
Smilax Taquetii Léveillé in Fedde, Rep. Spec. Nov. **10**: 372 (1912).
Smilax China L. f. *obtusa* Léveillé in Mem. Pontif. Accad. Nuov. Lincei, **24**: 344 (Liliac. 10) (1906).

Korea. Quelpaert: in silvis Hogno et Hallisan, *E. Taquet,* nos. 3306, 3307, 3308, Jan., May, Aug. 1909 (syntypes of *S. Taquetii;* photo. of 3306 and isotypes of nos. 3306, 3307 and 3308 in A. A.).

China. Kiangsu: Tou-gou-lin, *Ch. d'Argy,* [1848–66] (holotype of *S. China* f. *obtusa;* photo. in A. A.).

Smilax Taquetii was first identified with *S. China* by Norton (l.c.). *Smilax China* f. *obtusa* does not seem to be different from typical *S. China.*

Smilax glauco-china Warburg in Bot. Jahrb. **29**: 255 (1900). — Wang & Tang in Sinensia, **5**: 420 (1934).
Smilax Bodinieri Léveillé & Vaniot apud Léveillé in Mem. Pontif. Accad. Nuov. Lincei, **23**: 355 (Liliac. 27) (1905).
Smilax China "L." sensu Léveillé, Fl. Kouy-Tchéou 256 (1914), quoad syn. *S. Bodinieri;* non Linnaeus.

China. Kweichou: monts de Hin-y-fou et Hin-y-hien, dans les haies, *E. Bodinier,* no. 1581, Apr. 13, 1897 (holotype of *S. Bodinieri;* photo. in A. A.).

Smilax Bodinieri was cited as a synonym of *S. China* L. by Léveillé in his Flore du Kouy-Tchéou, but Wang & Tang referred it to *S. glauco-china.*

Smilax menispermoidea A. De Candolle, Monog. Phan. **1**: 108 (1878). — Wang & Tang in Sinensia, **5**: 420 (1934).

Smilax luteocaulis Léveillé in Fedde, Rep. Spec. Nov. **13**: 339 (1914); Cat. Pl. Yun-Nan, 169 (1916).

CHINA. Yunnan: brousse du mont To-chan, 3200 m., *E. E. Maire*, June, 1913 (holotype of *S. luteocaulis;* merotype in A. A.).

The specimen agrees perfectly with typical *S. menispermoidea*.

Smilax stemonifolia Léveillé & Vaniot apud Léveillé in Mem. Pontif. Accad. Nuov. Lincei **23**: 356 (Liliac. 28) (1905). — Wang in Bull. Fan Mem. Inst. Biol. **5**: 117 (1934).

CHINA. Hongkong: bois le long de Bowenroad, très rare, *E. Bodinier*, no. 804, Aug. 4, 1894 (holotype; photo. in A. A.).

The type specimen of this species is sterile, but Wang (l.c.) refers to it two other specimens, one from Hunan collected by H. F. Chow and P. Ou-yang, no. 46102, with young fruit, and one from Anhwei collected by F. T. Wang, no. 23860, sterile. Wang states that it is closely related to *S. Bockii* Warb. which differs in its much narrower leaves rounded at the base and in longer pedicels. It may also be near *S. longipes* Warb.

Smilax castaneiflora Léveillé in Bull. Acad. Géog. Bot. **25**: 39 (1915); Cat. Pl. Yun-Nan, 168 (1916). — Rehder in Jour. Arnold Arb. **10**: 111 (1929).

Smilax microphylla "Wright" sensu Wang & Tang in Sinensia, **5**: 418 (1934) quoad synon. *S. castaneiflora;* non Wright.

CHINA. Yunnan: brousse des mont. à Tong-tchouan, alt. 2700 m., *E. E. Maire*, June 1912, "arbuste grimpant, fleurs chocolat, fruits noirs" (holotype; merotype in A. A.).

In general appearance this species resembles *S. Bockii* Warb., but the branches are angled and quite spiny, the leaves are short-cordate, lanceolate, broad at the base and partly constricted below the middle into the narrow long-acuminate upper part. By Wang & Tang the species was referred to *S. microphylla* Wright, but it differs from that species in the long peduncle, the gradually acuminate cordate leaves, often somewhat restricted below the middle and green beneath. I have been unable to identify this species with any Chinese species I know. Handel-Mazzetti, no. 10379, from Kweichou may belong here, but it has broader leaves and is not spiny.

Smilax micropoda A. DC. var. **reflexa** Norton in Sargent, Pl. Wilson. **3**: 6 (1916).

Smilax Lebrunii Léveillé, Fl. Kouy-Tchéou, 257 (1914). — Wang & Tang in Sinensia, **5**: 421 (1934), "Lebranii." — **Synon. nov.**

China. Kweichou: bois sacré de Ban-gnien, 1100 m., *J. Esquirol,* no. 3518, March 19, 1912 (holotype of *S. Lebrunii;* photo. in A. A.).

Wang & Tang keep *S. Lebrunii* as a distinct species and refer to it three specimens from Kwangsi, R. C. Ching 5846, 6992 and 7201 which I have not seen.

Smilax tortopetiolata Léveillé & Vaniot apud Léveillé in Mem. Pontif. Accad. Nuov. Lincei **23:** 354 (Liliac. 26) (1905); Fl. Kouy-Tchéou, 258 (1914). — Wang & Tang in Sinensia, **5:** 422 (1934), excl. synon.

Smilax opaca (A. DC.) Norton in Sargent, Pl. Wilson. **3:** 11 (1916). — **Synon. nov.**

China. Kweichou: Pin-fa, bois, *J. Cavalerie,* no. 1312, March 18, 1902 (holotype of *S. tortopetiolata;* photo. in A. A.).

This species had not yet been reported from western China; it seems common in southeastern China and is represented in this herbarium by many specimens from Fukien, Kwangtung, Hainan and Kwangsi. I have been unable to find any specific difference between *S. opaca* and *S. tortopetiolata* which has to replace the former on account of priority.

Smilax cocculoides Warb. var. **lanceolata** Norton in Sargent, Pl. Wilson. **3:** 11 (1916).

Smilax Pinfaensis Léveillé & Vaniot apud Léveillé in Mem. Pontif. Accad. Nuov. Lincei, **23:** 355 (Liliac. 27) (1905). — Léveillé, Fl. Kouy-Tchéou, 257 (1914). — **Synon. nov.**

Smilax tortopetiolata "Lévl. & Vant." sensu Wang & Tang in Sinensia, **5:** 422 (1934), p.p., quoad synon. *S. pinfaensis.*

China. Kweichou: Pin-fa, *J. Cavalerie* no. 1311, March 18, 1902, "fl. verte" (holotype of *S. pinfaensis;* photo. in A. A.).

Smilax pinfaensis is apparently identical with *S. cocculoides* var. *lanceolata* Norton, the type of which is in fruit, and which I have before me. The flowers agree with those of typical *S. cocculoides,* as represented by Wilson, no. 3252. Wang & Tang (l.c.) refer *S. pinfaensis* as a synonym to *S. tortopetiolata,* but it is easily distinguished from the latter by the narrow-lanceolate, long-acuminate leaves, the slender peduncles much longer than the petioles and the short stamens.

Smilax Lyi Léveillé in Fedde, Rep. Spec. Nov. **8:** 171 (1910); Fl. Kouy-Tchéou, 257 (1914). — Wang & Tang in Sinensia, **5:** 421 (1934).

China. Kweichou: Pin-fa, montagnes, *J. Cavalerie,* no. 1406, Sept. 27, 1903 "fl. vert-jaune" (holotype; photo. in A. A.).

This species was kept distinct by Wang & Tang. The rather meagre specimen which consists of a branch with two leaves and an inflorescence in bud, resembles *S. stenophylla* A. Gray from the Liukiu Islands and Formosa, but with the scant material at hand, I hesitate to consider these geographically widely separated species identical.

Smilax perfoliata Loureiro, Fl. Cochinch. 622 (1790). — Wang & Tang in Sinensia, **5**: 422 (1934).

Smilax perulata Léveillé & Vaniot in Fedde, Rep. Spec. Nov. **9**: 78 (1910). — Léveillé, Fl. Kouy-Tchéou, 257 (1914).

CHINA. Kweichou: Lo-fou, *J. Cavalerie*, no. 3648, March 1909 (holotype of *S. perulata;* merotype in A. A.).

This species was identified first by Wang & Tang with *S. perfoliata* Lour. (*S. ocreata* A. DC.).

Heterosmilax Gaudichaudiana (Kunth) Maximowicz in Bull. Acad. St. Pétersb. **17**: 176 (1872); in Mél. Biol. **8**: 415 (1872). — A. DeCandolle, Monog. Phan. **1**: 44 (1878). — Léveillé in Mem. Pontif. Accad. Nuov. Lincei, **23**: 350 (Liliac. 22) (1905).

Heterosmilax Gaudichaudiana var. *latifolia* Bodinier ex Léveillé l.c. (1905).

CHINA. Hongkong: bord de l'Aquéduc, près Richmond Terrace, *E. Bodinier*, Aug. 22, 1894 (holotype of *H. Gaudichaudiana* var. *latifolia;* photo. in A. A.).

In the shape and measurements of the leaves Léveillé's variety agrees with DeCandolle's var. ∝ *Gaudichaudiana* (l.c.), which represents the type of the species. It seems doubtful whether this and var. β *hongkongensis* (Seem.) A. DC., (l.c.) are sufficiently distinct to be maintained as varieties.

TACCACEAE

Tacca Esquirolii (Lévl.), comb. nov.

Clerodendron Esquirolii Léveillé in Fedde, Rep. Spec. Nov. **11**: 298 (1912); Fl. Kouy-Tchéou, 439 (1915).

Tacca Paxiana Limpricht f. in Engler, Pflanzenreich, IV. **42**: 16 (1928). — P'ei in Mem. Sci. Soc. China, **1**, no. 3, p. 162 (1932).

CHINA. Kweichou: bois de Ta-Tham, très ombreux et chaud, *J. Esquirol*, no. 2802, May 1912, "toute l'inflorescence rouge, lie de vin, feuilles radicales, fleur 1 m. de haut sur tige simple" (holotype of *Clerodendron Esquirolii;* photo. in A. A.).

Léveillé's species was first identified by the writer with *Tacca Paxiana* (see P'ei, l.c.).

SALICACEAE[1]

Populus adenopoda Maximowicz in Bull. Soc. Nat. Moscou, **54:** 50 (1879). — Léveillé, Fl. Kouy-Tchéou, 380 (1915); Cat. Pl. Yun-Nan, 250 (1917). — Handel-Mazzetti, Symb. Sin. **7:** 58 (1929).

Populus macranthela Léveillé & Vaniot in Bull. Soc. Bot. France, **52:** 142 (March 1905); in Monde Pl. **12:** 9 (1910); in Fedde, Rep. Spec. Nov. **8:** 446 (1910). — Rehder in Jour. Arnold Arb. **10:** 111 (1929).

Populus Duclouxiana Dode in Bull. Soc. Nat. Hist. Autun, **18:** 190, t. 11, f. 329 (Extr. Monog. ined. Populus, 32) (1905).

Populus rotundifolia Griff. var. *Duclouxiana* (Dode) Gombocz in Math. Termesz. Közl. **30:** 130 (Monog. Gen. Populi) (1908). — Schneider in Sargent, Pl. Wilson. **3:** 25 (1916).

Populus rotundifolia Griff. × *macranthela* Gombocz in Bot. Közl. **10:** 25, (7) (1910). — Léveillé, Fl. Kouy-Tchéou, 380 (1915).

China. Kweichou: Pin-fa, *J. Cavalerie*, no. 974, April 1, 1903, "grande arbre" (holotype of *P. macranthela;* photo. in A. A.). Yunnan: Ko-kouy près Tchao-tong, *Père Marc Mey* in herb. *F. Ducloux*, no. 667, in 1906 (in hb. Léveillé and in hb. Univ. Calif. sub *P. macranthela;* isotypes of *P. Duclouxiana* Dode; photos. in A. A.).

In my earlier account of *P. macranthela*, I had considered it a species distinct from *P. adenopoda*, chiefly on account of the absence of the glands at the base of the blade of the leaves, their glabrousness and coarser serration. In comparing a large series of specimens of *P. adenopoda* one finds a great variability in these characters; though the glands are usually conspicuous, they may occasionally be small and partly lacking, as in Wilson's no. 724 from Hupeh, and in Steward, Chiao and Cheo, no. 294, from Kweichou. One of the two mature leaves of Ducloux's specimen in the herbarium of the University of California has an almost suborbicular shape, but on the material from trees cultivated in the Arnold Arboretum similar leaves can be found. Both specimens I have seen of Ducloux's no. 667 bear the name *P. macranthela* in Léveillé's handwriting. Neither Dode nor Gombocz give an exact citation of the specimen upon which *P. Duclouxiana* is based, but I assume that the species is based on Ducloux's no. 667.

Salix Cavaleriei Léveillé. — Rehder in Jour. Arnold Arb. **10:** 113 (1929). — Handel-Mazzetti, Symb. Sin. **7:** 61 (1929).

Salix erioclada Léveillé. — Rehder, l.c. 115 (1929). — Handel-Mazzetti, l.c. 64, fig. 1, 1. 2 (1929).

Handel-Mazzetti gives a detailed description of the species and figures staminate and pistillate flowers.

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Salix luctuosa Léveillé. — Rehder, l.c. 115 (1929). — Handel-Mazzetti, l.c. 68 (1929).

Handel-Mazzetti gives a full description of the pistillate flowers and refers *S. dyscrita* Schneid. as a synonym to this species.

Salix Duclouxii Léveillé. — Rehder, l.c. (1929). — Handel-Mazzetti, l.c. 87 (1929).

Salix kouytchensis (Lévl.) Schneider in Sargent, Pl. Wilson. **3**: 171 (1916). — Rehder, l.c. 117 (1929).

Handel-Mazzetti unites *S. kouytchensis* (Lévl.) Schneid. with *S. Duclouxii* and discusses the close relation of the latter to *S. Bockii* Seemen and *S. variegata* Franch., but prefers to keep these species distinct for the present.

MYRICACEAE[1]

Myrica esculenta Hamilton ex D. Don, Prodr. Fl. Nepal, 56 (1825).

Litsea myricopsis Léveillé, Cat. Pl. Yun-Nan, 150 (1916). — **Synon. nov.**

CHINA. K w e i c h o u : près Tchang-pou, *J. Cavalerie,* no. 2697, Nov. 3, 1905, "petit arbre" (holotype of *Litsea myricopsis;* merotype in A. A.).

Myrica esculenta has been collected in Kweichou also by Handel-Mazzetti (no. 10852).

Myrica adenophora Hance in Jour. Bot. **21**: 357 (1883). — Léveillé, Fl. Kouy-Tchéou, 281 (1914).

Litsea Mairei Léveillé, Cat. Pl. Yun-Nan, 150 (1916). — **Synon. nov.**

CHINA. Y u n n a n : collines arides incultes de Tché-hay, alt. 2600 m., *E. E. Maire,* March, 1912 "arbousier, arbuste rameuse, fleur blanc-verdâtre" (holotype of *Litsea Mairei;* merotype in A. A.).

Myrica adenophora does not seem to have been recorded from Yunnan before, nor from Kweichou, for I feel sure that Esquirol no. 3296 cited by Léveillé in his Flore du Kouy-Tchéou under that species (l.c.) does not belong here, but I have not seen it.

BETULACEAE[2]

Alnus Fauriei Léveillé in Bull. Soc. Bot. France, **51**: 423 (1904). — Rehder in Jour. Arnold Arb. **10**: 118 (1929).

JAPAN. H o n d o : in monte Gurvassan, *U. Faurie,* no. 783, Sept. 28, 1897 (holotype; photo. in A. A.).

The type specimen bears an identification label by Koidzumi with

[1]See Vol. **10**: 118.

[2]See Vol. **10**: 118.

the legend "*Alnus cylindrostachya* (Winkl.) Koidz." Though Winkler's name, *A. glutinosa* var. *cylindrostachya*, was published June 17, 1904, while Léveillé's name did not appear before November 1904, Léveillé's binomial has precedence over Winkler's varietal name.

Alnus nepalensis D. Don, Prodr. Fl. Nepal. 58 (1825). — Léveillé, Fl. Kouy-Tchéou, 124 (1914); Cat. Pl. Yun-Nan, 66 (1916).

Alnus Mairei Léveillé in Bull. Géog. Bot. **24**: 283 (1914).

China. Yunnan: vallées et montagnes de Tong-tchouan, 2500–2700 m., *E. E. Maire*, Nov. 1913, "grand arbre, chatons jaunes" (holotype of *A. Mairei;* photo. in A. A.).

Alnus Mairei was referred to *A. nepalensis* by Léveillé himself in 1916.

Carpinus Seemeniana Diels in Bot. Jahrb. **29**: 279 (1900). — Schneider in Sargent, Pl. Wilson. **2**: 430 (1916).

Carpinus pinfaensis Léveillé & Vaniot in Bull. Soc. Bot. France, **52**: 142 (1905).

Carpinus pubescens Burkill sensu Winkler in Bot. Jahrb. **51**: 501 (1914), p.p., quoad syn. *C. pinfaensis* et *C. Seemeniana*. — Léveillé, Fl. Kouy-Tchéou, 125 (1914). — Hu in Sunyatsenia, **1**: 119 (1933).

China. Kweichou: Pin-fa, *J. Cavalerie*, no. 1011, May 28, 1903, "arbre" (holotype of *C. pinfaensis;* photo. in A. A.).

Carpinus pinfaensis was first referred to *C. pubescens* (including *C. Seemeniana*) by Winkler in 1914, but in 1916 it was placed under *C. Seemeniana* by Schneider, where it certainly belongs if *C. Seemeniana* and *C. pubescens* are considered distinct. These two species and also *C. austrosinensis* Hu are closely related and perhaps best united under *C. pubescens* with one or two varieties, but at present I prefer to keep *C. Seemeniana* as a species, since the extreme forms are quite distinct. *Carpinus austrosinensis* is nearer to the latter.

Carpinus laxiflora Blume, Mus. Bot. Lugd.-Bat. **1**: 309 (1850). — Schneider in Sargent, Pl. Wilson. **2**: 438 (1916).

? *Carpinus laxiflora* Bl. var. *chartacea* Léveillé in Bull. Soc. Bot. France, **51**: 424 (1904).

Japan: without locality and collector (holotype of var. *chartacea;* ex Léveillé).

No specimen named *C. laxifolia* var. *chartacea* can be found in the Léveillé herbarium, but I have no doubt that it is but a slight variation of *C. laxiflora* under which it was placed by Schneider in 1916.

FAGACEAE[1]

Castanea mollissima Blume in Mus. Bot. Lugd.-Bat. **1**: 286 (1850).

Castanopsis yunnanensis (Franch.) Léveillé, Cat. Pl. Yun-Nan, 66 (1916), Syn.: "(*C. vulgaris* L., p.p.)" — Camus, Châtaigniers, 485 (1929).

The combination *Castanopsis yunnanensis* was published by Léveillé without any citation of a specimen. It is based on *Castanea vulgaris* var. *yunnanensis* Franchet which is a synonym of *C. mollissima;* also the citation by Léveillé of *C. vulgaris* L., p.p., as a synonym seems to indicate that it is a true *Castanea.* It can, therefore, hardly be referred to any other species than *C. mollissima* which is common in Yunnan; probably to this species belongs also *C. sativa* Mill. cited in Cat. Pl. Yun-Nan, 66.

Castanopsis cuspidata (Thbg.) Schottky in Bot. Jahrb. **47**: 625 (1912).

Castanea Fauriei Léveillé & Vaniot in Bull. Soc. Bot. France, **52**: 142 (1905). — Camus, Châtaigniers, 241 (1929). — **Synon. nov.**

JAPAN. Kiushu: autour de Nagasaki, *U. Faurie,* no. 3681, June 1899 (holotype of *C. Fauriei;* isotype in A. A.).

Miss Camus enumerated *C. Fauriei* under the doubtful species of *Castanea* with a note that it is probably a *Castanopsis.*

Castanopsis hystrix (Hook. f. & Th.) A. DeCandolle in Jour. Bot. **1**: 182 (1863); Prodr. **16**[2]: 111 (1864). — Léveillé, Cat. Pl. Yun-Nan, 66 (1916). — Rehder in Jour. Arnold Arb. **10**: 118 (1929).

Castanea Bodinieri Léveillé & Vaniot in Bull. Soc. Bot. France, **52**: 142 (1905). — Léveillé, Cat. Pl. Yun-Nan, 66 (1916). — Camus, Châtaigniers, 241 (1929).

Castanopsis Bodinieri (Lévl. & Vant.) Koidzumi in Tokyo Bot. Mag. **30**: 100 (1916) "Boodinieri."

Quercus brunnea Léveillé in Fedde, Rep. Spec. Nov. **12**: 364 (1913); Fl. Kouy-Tchéou, 127 (1914). — Camus, Châtaigniers, 482 (1929); Atlas, pl. 28, fig. 9–11, IX. f. 9–17 (1928).

Castanopsis brunnea (Lévl.) Camus, Châtaigniers, Atlas, pl. 28 (1928).

CHINA. Kweichou: Pin-fa, bois, *J. Cavalerie,* no. 2299, Apr. 13, 1905 (holotype of *Q. brunnea;* photo. in A. A.). Yunnan: environs de Yun-nan-sen, bois de la pagode de Kiang-tchou-se, *E. Bodinier,* Feb. 2, 1897, "grand arbuste ou petit arbre, fruits en long épis à glands sessiles serrés" (holotype of *Castanea Bodinieri;* photo. in A. A.).

Castanea Bodinieri is enumerated by Miss Camus (l.c.) under in-

[1]See Vol. **10**: 118.

completely known species of *Castanea*. *Quercus brunnea* she describes under doubtful species of *Castanopsis* and says "probablement var. ou sous-espèce du *C. Hystrix*."

Castanopsis Eyrei (Champ.) Tutcher in Jour. Linn. Soc. Bot. **37:** 68 (1905). — Chun in Sunyatsenia, **1:** 217, pl. 35 (1934), excl. syn. *Q. Castanopsis*.

Castanopsis caudata Franchet in Nouv. Arch. Mus. Paris, ser. 3, **7:** 87 (Pl. David. **1:** 277) (1884). — Rehder in Jour. Arnold Arb. **10:** 119 (1929), excl. syn. *Q. Castanopsis*. — Handel-Mazzetti, Symb. Sin. **7:** 28 (1929).

Quercus trinervis Léveillé in Fedde, Rep. Spec. Nov. **12:** 364 (1913); Fl. Kouy-Tchéou, 128 (1914).

Quercus cepifera Léveillé, l.c. 364 (1913); l.c. 127 (1914), pro parte, quoad specimina foliifera.

Castanopsis asymetrica Léveillé, Fl. Kouy-Tchéou, 125 (1914). — A. Camus, Châtaigniers, 472 (1929) "asymmetrica"; Atlas, pl. 72, fig. 15, XXXIV, fig. 17–19 (1928).

Castanopsis neo-Cavalerici A. Camus, Châtaigniers, 375 (1929); Atlas, pl. 72, fig. 1–12, XXXIV, fig. 8–15 (1928).

Castanopsis trinervis (Lévl.) A. Camus, op. cit. 400 (1929); Atlas, pl. 70, fig. 1–7, XXXIII, fig. 1–7 (1928).

Castanopsis tribuloides var. *echidnocarpa* King sensu Rehder in Jour. Arnold Arb. **10:** 119 (1929); non King apud Hooker f. (1888).

China. Kweichou: *J. Cavalerie*, no. 3275, Aug. 20, 1908 (holotype of *Q. trinervis;* photo. in A. A.); sud de Pin-fa, rare, *J. Cavalerie*, no. 2341 (in part, except fruit), June 8, 1905 "fruits ci-joints trouvés par terre; apartiennent-ils à cet arbre" (holotype of *Q. cepifera*, except fruit; photo. in A. A.); Kouy-yang, monts du Collège, *J. Chaffanjon* in herb. *Bodinier*, no. 2235, Apr. 15, 1898, "arbre, fleurs blanches" (syntype of *Castanopsis asymetrica;* merotype in A. A.); Kouy-yang, bois d'une pagode, *J. Cavalerie*, no. 2078 [cited as 2178 by Léveillé], "arbre" (syntype of *C. asymetrica;* photo. in A. A.); Kien-lin-chan, *J. Esquirol*, no. 17, May 2, 1904, "feuilles de camélia" (syntype of *C. asymetrica;* photo. in A. A.).

I agree with Chun in considering *Castanopsis Eyrei* and *C. caudata* identical. Miss Camus places *C. asymmetrica, C. Eyrei* and *C. caudata* among the incompletely known species and describes *C. trinervis* as a distinct species. Handel-Mazzetti cites *Castanopsis asymetrica* as a synonym of *C. caudata* Franch.

Castanopsis neo-Cavaleriei A. Camus in Bull. Bimens. Soc. Linn. Lyon, 8: 87 (1929); Châtaigniers, 375 (1929); Atlas, pl. 72, fig. 1–12, XXIV, fig. 8–15 (1928).

Quercus Cavaleriei Léveillé & Vaniot in Bull. Soc. Bot. France, **52**: 142 (1905); Fl. Kouy-Tchéou, 127 (1914).
Quercus Castanopsis Léveillé in Fedde, Rep. Spec. Nov. **12**: 363 (1913); Fl. Kouy-Tchéou, 127 (1914).
Castanopsis caudata Franchet sensu Rehder in Jour. Arnold Arb. **10**: 119 (1929), quoad syn. *Q. Castanopsis;* non Franchet.
Castanopsis tribuloides var. *echidnocarpa* King sensu Rehder, l.c. (1929); non King ex Hooker f.
Castanopsis eyrei (Champ.) Tutcher sensu Chun in Sunyatsenia, **1**: 217 (1934), quoad syn. *Q. Castanopsis;* non (Champ.) Tutcher.

CHINA. Kweichou: Pin-fa, hautes montagnes, *J. Cavalerie,* no. 57 (in part; young fruit), July 15, 1902, "petit arbre" (holotype of *Quercus Cavaleriei;* photo. in A. A.); Pin-fa, Ma-jo, hautes montagnes, rare, *J. Cavalerie,* no. 57 (in part; flowers), May 1902 (syntype of *Q. Castanopsis;* merotype in A. A.); same locality, *J. Cavalerie,* no. 57, Aug. 1908 (syntype of *Q. Castanopsis;* merotype in A. A.); same locality, *J. Cavalerie,* no. 1268, July 1908 (syntype of *Q. Castanopsis;* ex Léveillé; ? merotype in A. A.).

This species is closely related to *C. Eyrei,* but differs in the thinly scurfy-tomentulose brownish under side of the leaves — quite glabrous in *C. Eyrei* — and in the larger, very oblique cupula with more distinct fascicles of spines nearly wanting on the ventral side. From *C. Fargesii* Franch. it differs in the broader leaves less densely tomentulose beneath, — in *C. Fargesii* the dense brown tomentum obscures the veinlets, — and in the larger apparently indehiscent cupula. Two fruiting spikes are figured by Miss Camus on pl. 72; fig. 3 apparently represents the young fruits of *Q. Cavaleriei,* while fig. 4–6 represent mature fruits of *Q. Castanopsis* collected in August.

The name *C. neo-Cavaleriei* for this species has to stand, since there exists already a *Castanopsis Cavaleriei* Lévl. of 1913 which, however, is not a *Castanopsis,* but represents *Sloanea sinensis* (Hance) Hu (see Jour. Arnold Arb. **15**: 89. 1934), and the specific epithet of the second synonym cannot be transferred to *Castanopsis,* since this would result in a tautonym.

Castanopsis tibetana Hance. — Rehder in Jour. Arnold Arb. **10**: 119 (1929).

Quercus Franchetiana Léveillé, Fl. Kouy-Tchéou, 128 (1915). — Camus, Châtaigniers, 485 (1929).

Miss Camus states that *C. Franchetiana* is perhaps identical with *C. tibetana;* in a note she says that the leaves of the former are quite different from those of Hance's type in shape, are very lustrous above and more waxy and less pubescent beneath but that she has seen an intermediate form.

Castanopsis cryptoneuron (Lévl.) Rehder in Jour. Arnold Arb. **10:** 119 (1929). — Camus, Châtaigniers, Atlas, pl. 54, fig. 1–4 (1928), nom. tantum; text, 418 (1929).

Miss Camus cites the combination as dating from her Atlas of 1928, but since the original binomial is not cited there, it cannot be considered as validly published.

Castanopsis spec. Rehder in Jour. Arnold Arb. **10:** 120 (1929).

Quercus Argyi Léveillé in Mem. Acad. Ci. Art. Barcelona, ser. 3, **12:** 548 (Cat. Pl. Kiang-Sou, 8) (1916).

China. Kiangsu: Sonosê, *Ch. d'Argy*, nos. 842, 856 [1846–66].

In the cover of *Q. Argyi* in Léveillé's herbarium, there are two specimens, no. 842 with pistillate and no. 856 with staminate flowers, both belonging apparently to the same species related to *C. Fargesii* Franch., but they have broader and more serrate leaves. Cavalerie's no. 2078 (not 2178) of which I stated (l.c.) that it may belong here, belongs to *C. Eyrei* (Champ.) Tutch. together with the other specimens of *Castanopsis asymetrica*.

Castanopsis spec.

Myrica Cavaleriei Léveillé in Fedde, Rep. Spec. Nov. **12:** 537 (1913), pro parte, quoad specim. ♀.

China. Kweichou: haut plateau, route de Pin-fa à Kouy-yang, *J. Cavalerie*, no. 3184, June 1908 (holotype of *Myrica Cavaleriei*, in part; photo. in A. A.).

Cavalerie's no. 3184 consists of two leafless branches, for which see *Quercus* spec. (p. 72), and a leafy branch with short axillary spikes of pistillate flowers and with lanceolate slender-petioled leaves 10–12 cm. long and about 2 cm. broad.

Quercus serrata Thunberg. — Rehder in Jour. Arnold Arb. **10:** 120 (1929).

Since the name *Q. serrata* Thbg. which correctly belongs to the species named *Q. glandulifera* Bl. has been applied by almost all authors, following Siebold and Zuccarini, to *Q. acutissima* Carruthers, it is advisable to consider *Q. serrata* a nomen ambiguum and use *Q. acutissima* and *Q. glandulifera* for the two species involved.

Quercus guyavaefolia Léveillé in Fedde, Rep. Spec. Nov. **12:** 363 (1913); Cat. Pl. Yun-Nan, 67 (1916) "guyavifolia." — Rehder in Jour. Arnold Arb. **10:** 121 (1929). — Camus, Chênes, Atlas, **1:** t. 35 (1934).

Quercus semecarpifolia Sm. var. *longispica* Handel-Mazzetti, Symb. Sin. 7: 39 (1929).

Handel-Mazzetti cites *Q. guyavaefolia* as a synonym of his *Q. semecarpifolia* var. *longispica*, but does not enumerate the type of Léveillé's species, and apparently bases his description on other specimens from Yunnan and also from Szechuan; Miss Camus' illustrations also are partly based on other specimens. The type specimen of *Q. guyavaefolia* has all the leaves entire.

Quercus Prainiana Léveillé. — Rehder in Jour. Arnold Arb. **10:** 121 (1929).

This species is figured by Léveillé in the manuscript work Cat. Ill. Pl. Seu-Tchouan on pl. 23 under the name *Q. Prainii*.

Quercus glauca Thunberg, Fl. Jap. 175 (1784). — Rehder in Jour. Arnold Arb. **10:** 121 (1929). — Handel-Mazzetti, Symb. Sin. **7:** 50 (1929).

Quercus Blakei Skan var. *Vaniotii* (Lévl.) Chun in Jour. Arnold Arb. **9:** 153 (1928).

Chun's new combination is based on *Q. Vaniotii* Lévl. and on Cavalerie, no. 3274 (not 3264, as cited), which undoubtedly belongs to *Q. glauca;* he evidently placed too much faith in Léveillé's statement, that *Q. Vaniotii* is very closely related to *Q. Blakei* Skan. The type specimen consists only of sterile branches; the leaves show the closely appressed pubescence of *Q. glauca*, while *Q. Blakei* has the leaves glabrous and green beneath, more gradually attenuate at base and with shorter appressed and fewer teeth. Handel-Mazzetti cites (l.c.) *Q. Vaniotii* as a synonym of *Q. glauca*.

Quercus spec. — Rehder in Jour. Arnold Arb. **10:** 122 (1929).

Myrica Cavaleriei Léveillé in Fedde, Rep. Spec. Nov. **12:** 537 (1913), pro parte, quoad specim. ♂.

CHINA. Kweichou: haut plateau, route de Pin-fa à Kouy-yang, *J. Cavalerie*, no. 3184 in part (♂), April, 1908 (holotype of *Myrica Cavaleriei*, in part; photo. in A. A.).

To *Quercus* belong two leafless branches with immature staminate catkins; for the pistillate specimen see *Castanopsis* spec. (p. 71).

MORACEAE[1]

Vanieria tricuspidata (Carr.) Hu in Jour. Arnold Arb. **5:** 228 (1924).

Cudrania tricuspidata Bureau in Lavallée, Arb. Segrez. 243 (1877). — Nakai, Fl. Sylv. Kor. **19:** 114 (1932).

[1]See Vol. **10:** 123.

Morus integrifolia Léveillé & Vaniot in Bull. Acad. Intern. Géog. Bot. **17**, no. 210–11, p. iii (1907). — Schneider in Sargent, Pl. Wilson. **3**: 301, in nota (1916).

China. Hopei: Tchao-tchao, cimetière, *L. Chanet,* no. 49, June 25, 1905. "fruit rouge à la maturitè" (holotype of *Morus integrifolia;* photo. in A. A.).

Nakai (l.c.) seems to have first referred *Morus integrifolia* to this species. As *Cudrania* Trècul, though proposed as a nomen conservandum, did not receive the unanimous vote of the Committee, I retain here the oldest generic name *Vanieria* Lour.

As Chanet collected his specimen in a cemetery, it was probably from a planted tree; the specimen has not been recorded as growing wild in Hopei, but we have specimens in the herbarium from the adjoining provinces — Shansi, Honan and Shantung.

Ficus gibbosa Bl. var. **cuspidifera** King. — Rehder in Jour. Arnold Arb. **10**: 123 (1929).

Ficus cuspidifera Miquel in London Jour. Bot. **7**: 434 (1848). — Handel-Mazzetti, Symb. Sin. **7**: 92 (1929).

Handel-Mazzetti cites *F. rhomboidalis* Lévl. & Vant. as a synonym of *F. cuspidifera.*

Ficus glaberrima Blume, Bijdr. 451 (1825).

Ficus suberosa Léveillé & Vaniot in Fedde, Rep. Spec. Nov. **8**: 549 (1910). — Léveillé, Fl. Kouy-Tchéou, 433 (1915). — Rehder in Jour. Arnold Arb. **10**: 131 (1929). — **Synon. nov.**

Ficus Blinii Léveillé & Vaniot, l.c. 550 (1910). — Léveillé, l.c. 429 (1915). — **Synon. nov.**

Ficus Feddei Léveillé & Vaniot, op. cit. **9**: 19 (1910). — **Synon. nov.**

Ficus Kingiana Léveillé, Fl. Kouy-Tchéou, 431 (1915), pro parte; non Hemsley. — **Synon. nov.**

China. Kweichou: Lo-fou, *J. Cavalerie,* no. 3597, March 1909, (holotype of *F. suberosa;* fragments in A. A.); Pia-ouai-lo, alt. 600 m., *J. Esquirol,* no. 2197, Sept. 1910 (cited under *F. suberosa* in Fl. Kouy-Tchéou; duplicate in A. A.); Lo-fou, *J. Cavalerie,* no. 3595, March 1909 (holotype of *F. Blinii;* merotype in A. A.); Lo-fou, *J. Cavalerie,* no. 3634, Oct. 1908 (holotype of *F. Feddei;* photo. in A. A.); Hua-kiang, *J. Cavalerie,* no. 2172, June 3, 1904 (syntype of *F. Kingiana;* photo. in A. A.).

In his Flore du Kouy-Tchéou, Léveillé refers *F. Feddei* as a synonym to *F. suberosa,* but keeps *F. Blinii* distinct. Cavalerie's no. 2172 is cited as a syntype of *F. Kingiana* by Léveillé, but the characters under which *F. Kingiana* appears in the key, exclude it, and therefore the other syntype which belongs to *F. pyriformis* Hook. & Arn. must be considered the real type of the species.

Ficus retusa Linnaeus, Mant. 129 (1767). — Léveillé, Cat. Pl. Yun-Nan, 275 (1917). — Handel-Mazzetti, Symb. Sin. **7:** 100 (1929).

Ficus retusiformis Léveillé in Fedde, Rep. Spec. Nov. **8:** 549 (1910); Fl. Kouy-Tchéou, 433 (1915).

CHINA. Kweichoʻu; Lou-fou, *J. Cavalerie,* no. 3601, March 1909 (holotype of *F. retusiformis;* merotype in A. A.).

Ficus retusiformis was first referred to *F. retusa* as a synonym by Handel-Mazzetti (l.c.).

Ficus lacor Hamilton. — Rehder in Jour. Arnold Arb. **10:** 124 (1929).

Ficus superba Miq. sensu Handel-Mazzetti, Symb. Sin. 7: 92 (1929), quoad syn. *F. Tenii;* vix Miq.

CHINA. Yunnan: Kiao-kia, *Siméon Ten,* no. 733, Jan. 5, 1906, "grand arbre" (holotype of *F. Tenii* in hb. Lévl., isotype in hb. Ducloux in hb. Univ. Calif.; photos. in A. A.).

Ficus Tenii Lévl. was referred by Handel-Mazzetti (l.c.) to *F. superba. Ficus pseudoreligiosa* Lévl. has smaller longer-stalked receptacles and distinctly cuneate leaves.

Ficus obscura Blume, Bijdr. 474 (1825). — Gagnepain in Lecomte, Fl. Gén. Indo-Chine, **5:** 792 (1928).

Ficus asymetrica Léveillé & Vaniot in Mem. Acad. Ci. Art. Barcelona, ser. 3, **6:** 147 (Ficus Spec. Chin. 9) (1907); in Fedde, Rep. Spec. Nov. **4:** 82 (1907). — Léveillé, Fl. Kouy-Tchéou, 429 (1915). — Rehder in Jour. Arnold Arb. **10:** 128 (1929). — **Synon. nov.**

CHINA. Kweichou: bord du Hoa-kiang, *L. Martin* in hb. *Bodinier,* no. 2577, Feb. 18, 1899 (holotype of *F. asymetrica;* merotype in A. A.); Lo-fou, *J. Cavalerie,* no. 3596, March 1909 (cited in Fl. Kouy-Tchéou [as 3796]; duplicates in A. A.); bord du Ta-ras rivière, *J. Esquirol,* nos. 2692, July 20, 1911, and 3549 (cited in Fl. Kouy-Tchéou; duplicates in A. A.).

Ficus asymetrica agrees well with *F. obscura* which has been reported from Kweichou by Gagnepain (l.c.) apparently based on Cavalerie 3596 named in the Paris Herbarium *F. obscura.* It is a species of wide distribution extending from the Malayan Archipelago to Tonkin, southern China and the eastern Himalayas.

Ficus longepedata Léveillé & Vaniot. — Rehder in Jour. Arnold Arb. **10:** 127 (1929). — Handel-Mazzetti, Symb. Sin. **7:** 93 (1929).

Handel-Mazzetti gives (l.c.) a complete description of the species, to which he refers *F. trichopoda* Léveillé and *F. sordida* Hand.-Mazz. as synonyms.

Ficus laevis Blume, Bijdr. 437 (1825).

Ficus Jamini Léveillé & Vaniot in Fedde, Rep. Spec. Nov. **8**: 550 (1910). — Léveillé, Fl. Kouy-Tchéou, 430 (1915). — Rehder in Jour. Arnold Arb. **10**: 129 (1929). — **Synon. nov.**

China. Kweichou: Lo-fou, *J. Cavalerie,* no. 3601, March 1909 (holotype of *F. Jamini;* merotype in A. A.).

The specimen cited represents the typical glabrous form to which belongs also Henry's no. 11823 from Yunnan.

Ficus scandens Roxburg, Fl. Ind. **3**: 536 (1832).

Ficus cantoniensis Bodinier ex Léveillé in Mem. Acad. Ci. Art. Barcelona, ser. 3, **6**: 148 (Ficus Spec. China, 10) (1907); in Fedde, Rep. Spec. Nov. **4**: 83 (1907). — **Synon. nov.**

China. Hongkong: introduit à Hongkong, où il est maintenant très commun sur les murs, *E. Bodinier,* no. 1253, July 7, 1895 (holotype of *F. cantoniensis;* merotype in A. A.).

Ficus scandens is not recorded in Hemsley, Index Florae Sinensis, nor in Dunn & Tutcher, Flora of Kwangtung and Hongkong, but it has been collected more recently in southern Yunnan and in Hainan.

Ficus foveolata Wall. — Rehder in Jour. Arnold Arb. **10**: 124 (1929). — Handel-Mazzetti, Symb. Sin. **7**: 95 (1929).

Handel-Mazzetti (l.c.) cites *F. rufipes* Lévl. as a synonym and points out that of the three syntypes cited only Cavalerie 340 belongs here, while Esquirol 75 and 76 represent Rubiaceae; the two last-named syntypes I have not yet seen.

Ficus foveolata var. **Thunbergii** (Maxim.) King. — Rehder in Jour. Arnold Arb. **10**: 125 (1929).

Ficus stipulata Thunberg, Diss. Ficus, 5, 8 (1786). — Nakai, Fl. Sylv. Kor. **19**: 124, t. 40 (1932).

Ficus hederifolia Léveillé. — Rehder, l.c. 129 (1929).

Ficus Fauriei var. *macrocarpa* Léveillé in Fedde, Rep. Spec. Nov. **11**: 65 (1912).

Korea. Quelpaert, add: scandens in rupibus, *E. Taquet,* no. 5972, Dec. 1911 "feuilles et fruits doubles du *F. Fauriei*" (holotype of *F. Fauriei* var. *macrocarpa;* photo. in A. A.); Hong-no, in declivibus altis, repens in rupibus et tapetem formans, *E. Taquet,* no. 4425, July 2, 1910 (holotype of *F. hederifolia* Lévl.; merotype in A. A.).

Nakai enumerates under *F. stipulata* (l.c.) as synonyms *F. hederifolia* Lévl. and *F. Fauriei* var. *macrocarpa* Lévl.

Ficus Martini Léveillé & Vaniot. — Rehder, l.c. 127 (1929). — Handel-Mazzetti, Symb. Sin. **7**: 95 (1929).

Ficus botryoides Léveillé & Vaniot in Mem. Acad. Ci. Art. Barcelona, ser. 3, **6**: 148 (Ficus Sp. Chin. 10) (1907); in Fedde, Rep. Spec. Nov. **4**: 83 (1907). — Léveillé, Fl. Kouy-Tchéou, 429 (1915). — Rehder in Jour. Arnold Arb. **10**: 128 (1929).

Ficus lacrymans Léveillé, Fl. Kouy-Tchéou, 431 (1915). — Rehder in Jour. Arnold Arb. **10**: 130 (1929).

Ficus kwangtungensis Merrill in Jour. Arnold Arb. **8**: 3 (1927). — **Synon. nov.**

CHINA. Kweichou, add: Ta-rin, alt. 900 m., *J. Esquirol*, no. 5373, April 12, 1913, "figuier pleureur" (holotype of *F. lacrymans;* merotype in A. A.); environs de Tsin-gay, rochers au bord de la rivière, à Cha-teou-tchay, *E. Bodinier*, no. 2653, June 27, 1899 (holotype of *F. botryoides;* merotype in A. A.).

Handel-Mazzetti l.c. places *F. lacrymans* with *F. Martini*, and I now think that he is right; leaves of thinner texture with slight reticulation occur occasionally on specimens from various localities and the habit seems to be extremely variable; on many specimens the branchlets are very long and slender and probably hang down from scandent stems, while other specimens are described as upright shrubs, as is the type of *F. kwangtungensis*. Though I have not seen the type of the last-named species, I have seen specimens from Kwangtung and Hainan determined by its author.

Ficus tikoua Bureau in Jour. de Bot. **2**: 213, pl. 7 (1888). — Léveillé, Cat. Pl. Yun-Nan, 275 (1917).

Ficus Bonatii Léveillé in Fedde, Rep. Spec. Nov. **6**: 112 (1908). — **Synon. nov.**

Ficus Bonatiana Léveillé, Cat. Pl. Yun-Nan, 274 (1917).

CHINA. Yunnan: Yunnan-sen, ravins du mont Tchong-chan, *F. Ducloux*, no. 732, Aug. 18, 1905 (holotype of *F. Bonatii* in herb. Bonati in Univ. Calif.; photo. in A. A.; isotype in herb. New York Bot. Gard.).

The specimen cited above differs somewhat from most of the material in this herbarium in the uniformly short petioles not exceeding 1 cm.

Ficus erecta Thunberg. — Rehder in Jour. Arnold Arb. **10**: 125 (1929). — Handel-Mazzetti, Symb. Sin. **7**: 100 (1929). — Nakai, Fl. Sylv. Kor. **19**: 121 (1932).

Nakai cites *F. Taquetii* as a synonym of *F. erecta*, and Handel-Mazzetti cites as synonyms besides *F. pseudopiriformis* and *F. Taqueti* also *F. Mairei* Lévl. which according to fragments from the type specimen belongs to *F. heteromorpha* Hemsl. (see Rehder, op. cit. 126).

Ficus erecta Thunb. var. **Sieboldi** (Miq.) King in Ann. Bot. Gard. Calcutta, **1**: 142 (1888). — Nakai, Fl. Sylv. Kor. **19**: 123, t. 39 (1932).

Ficus pseudo-piriformis Léveillé & Vaniot in Fedde, Rep. Spec. Nov. **5**: 282 (1908). — Nakai in Jour. Coll. Sci. Tokyo, **31**: 199 (Fl. Kor.) (1911).

Ficus erecta Thunb. — Rehder in Jour. Arnold Arb. **10**: 125 (1929), in part.

KOREA. Quelpaert: Hong-no, secus torrentes, *U. Faurie*, no. 1991, July 1907; in petrosis, *U. Faurie*, 2024, July 1907 (syntypes of *F. pseudo-piriformis;* fragments of no. 1991 in A. A.; no. 2024 ex Léveillé); secus torrentes, alt. 400 m., *E. Taquet*, no. 4422, July 28, 1910 (in hb. Léveillé sub *F. pseudo-piriformis;* merotype in A. A.).

According to Léveillé's description Faurie no. 2024 belongs here, but an isotype of this number in the A. A. herbarium is typical *F. erecta*. On the other hand, a duplicate of Taquet no. 900, which is cited by Léveillé under *F. Taqueti*, belongs to var. *Sieboldi*. *Ficus Taqueti*, according to Léveillé's description, represents typical *F. erecta*, while *F. pseudo-piriformis* agrees with var. *Sieboldi*. Nakai (l.c. 1932) cites *F. pseudo-piriformis* under *F. erecta* var. *Sieboldi*.

Ficus hirta Vahl. — Rehder, l.c. 126 (1929). — Handel-Mazzetti, Symb. Sin. **7**: 99, 100 (1929).

Handel-Mazzetti (l.c. 100) identifies *F. Porteri* Lévl. & Vant. with *F. hirta* Vahl.

Ficus pandurata Hance in Ann. Sci. Nat. ser. 4, **18**: 229 (1862).

Ficus cuneata Léveillé & Vaniot in Mem. Acad. Ci. Art. Barcelona, ser. 3, **6**: 149 (Ficus Sp. Chin. 11) (1907); in Fedde, Rep. Spec. Nov. **4**: 84 (1907). — Léveillé, Fl. Kouy-Tchéou, 429 (1915). — Rehder in Jour. Arnold Arb. **10**: 128 (1929). — Pro parte, quoad specim. Bodinier 2363. — Non Blume, nec Wallich, nec Miquel.

CHINA. Kweichou: environs de Kouy-yang, mont du College, gorge de Yan-pa, rocailles (May 16, 1898), environs de Tou-chan (May 31), *E. Bodinier*, no. 2363, "arbuste" (syntype of *F. cuneata;* photo. in A. A.).

On the label of Bodinier's no. 2363, two localities are given, but there is only one specimen on the sheet; the name *F. cuneata* does not appear on the label.

Here belongs probably also *F. comata* Hand.-Mazz. as suggested by F. P. Metcalf in a note on one of the sheets of that species.

Ficus heteromorpha Hemsley. — Rehder in Jour. Arnold Arb. **10**: 126 (1929). — Handel-Mazzetti, Symb. Sin. **7**: 98, 100 (1929).

Ficus cuneata Léveillé & Vaniot in Mem. Acad. Ci. Art. Barcelona, ser. 3, **6**: 149 (Ficus Sp. Chin. 11) (1907); in Fedde, Rep. Spec. Nov. **4**: 84 (1907). — Léveillé, Fl. Kouy-Tchéou, 429 (1915). — Rehder in Jour. Arnold Arb. **10**: 128 (1929). — Pro parte, quoad specim. Cavalerie 1351. — Non Blume, nec Wallich, nec Miquel. — **Synon. nov.**

CHINA. K w e i c h o u, add: Pin-fa, *J. Cavalerie,* no. 1351, Sept. 8, 1903, (syntype of *F. cuneata;* photo. in A. A.).

The other syntype of *F. cuneata* differing in the stalked receptacles seems referable to *F. pandurata* Hce.

Handel-Mazzetti (l.c. 100) refers *F. pinfaensis* to his *F. comata,* but the type of *F. pinfaensis,* Cavalerie 532, differs from *F. comata* in the sessile fruits, longer petioles and in the venation of the generally oblong and quite glabrous leaves rounded at base. To *F. heteromorpha* Handel-Mazzetti refers *F. Stapfii* Lévl., but Léveillé's species, though apparently related to *F. heteromorpha,* differs in its leaves being rather densely hirsute on both sides and scarcely acuminate.

Ficus formosana Maximowicz. — Rehder in Jour. Arnold Arb. **10**: 127 (1929). — Handel-Mazzetti, Symb. Sin. **7**: 98, 100 (1929).

Ficus rhomboidalis Léveillé, Fl. Kouy-Tchéou 433 (1915), p.p., quoad specim. Esquirol 3267. — Non Léveillé & Vaniot (1907).

CHINA. K w e i c h o u: Teng-Tchéou, jardin du P. Marchand, *Esquirol,* no. 3267, June 22, 1902 (cited in Fl. Kouy-Tchéou; duplicate in A. A.).

The type of *F. rhomboidalis* belongs to *F. gibbosa* var. *cuspidifera* (Miq.) King.

Ficus lageniformis Lévl. & Vant. was referred by Handel-Mazzetti (l.c. 100) to *F. formosana,* as already identified by the writer (l.c.)

Ficus laceratifolia Léveillé & Vaniot. — Rehder in Jour. Arnold Arb. **10**: 130 (1929).

This species has been referred tentatively by Handel-Mazzetti (Symb. Sin. **7**: 100) to his *F. comata* as a form with lacerated leaves, but looks quite distinct. It is represented in this herbarium by a photograph of the type with fragments and by two specimens collected by W. P. Fang in Szechuan, no. 2415, from Mt. Omei and no. 5645 from Nanchuan Hsien.

Ficus Cavaleriei Léveillé & Vaniot. — Rehder in Jour. Arnold Arb. **10**: 128 (1929).

This species seems related to *F. pyriformis* Hook. & Arn., but it is quite glabrous and the veins of the leaves diverge at nearly right angles;

it also resembles *F. stenophylla* Hemsley, but the leaves are broader and gradually narrowed from the middle to the ends.

Ficus pyriformis Hooker & Arnott, Bot. Beechey Voy. 216 (1841). — Léveillé, Cat. Pl. Yun-Nan, 275 (1917), "*piriformis*." — Handel-Mazzetti, Symb. Sin. **7:** 98, 100 (1929).

Ficus Nerium Léveillé & Vaniot in Fedde, Rep. Spec. Nov. **4:** 66 (1907). — Léveillé, Fl. Kouy-Tchéou, 432 (1915). — Rehder in Jour. Arnold Arb. **10:** 130 (1929).

Ficus Kingiana Léveillé, Fl. Kouy-Tchéou, 431 (1915), pro parte; non Hemsley. — **Synon. nov.**

China. Kweichou: without locality, *J. Esquirol* (holotype of *F. Nerium;* fragments in A. A.); Tchen-fong, *J. Esquirol,* no. 914 (cited in Fl. Kouy-Tchéou; duplicate in A. A.); Ly-po, *J. Cavalerie,* Feb. 15, 1900 (syntype of *F. Kingiana;* merotype in A. A.).

Ficus Nerium was first referred to *F. pyriformis* by Handel-Mazzetti (l.c. 100). *Ficus Kingiana* appears in Fl. Kouy-Tchéou without description, but as its characters can be partly ascertained from the key, it is not a nomen nudum; of the two syntypes, only the specimen from Ly-po belongs here and must be considered the type (lectotype) since it fits the characters given in the key, while the other specimen does not.

Ficus pyriformis Hook. & Arn. var. **ischnopoda** King in Ann. Bot. Gard. Calcutta, **1:** 158, pl. 201c (1888).

Ficus macropodocarpa Léveillé & Vaniot in Fedde, Rep. Spec. Nov. **4:** 66 (1907). — Léveillé, Fl. Kouy-Tchéou, 431 (1915). — Rehder in Jour. Arnold Arb. **10:** 130 (1929). — **Synon. nov.**

China. Kweichou: without locality, *J. Esquirol,* no. 838 (holotype of *F. macropodocarpa;* merotype in A. A.); rivière de Loufou, *J. Esquirol,* no. 2216, Sept. 1910 (cited in Fl. Kouy-Tchéou; duplicate in A. A.).

Ficus macropodocarpa was first referred by Handel-Mazzetti to *F. pyriformis* (l.c. 100); on account of the long-peduncled receptacles, it seems referable to var. *ischnopoda.*

Ficus Esquirolii Léveillé & Vaniot in Mem. Acad. Ci. Art. Barcelona, ser. 3, **6:** 150 (Ficus Spec. Chin. 12) (1907); in Fedde, Rep. Spec. Nov. **4:** 84 (1907). — Léveillé, Fl. Kouy-Tchéou, 430 (1915).

Ficus stenophylla Hemsley in Hooker's Icon. **26:** t. 2536 (1897), p.p., excl. parte typ. — Handel-Mazzetti, Symb. Sin. **7:** 98 (1929).

China. Kweichou: préfecture de Hin-y-fou, *J. Esquirol* in hb. *Bodinier,* no. 2588, April 1899 (holotype of *F. Esquirolii;* photo. in A. A.).

This species seems to be closely related to *F. pyriformis* Hook. & Arn. and to *F. stenophylla* Hemsl.; from the former it differs in the narrower long-caudate leaves, subsessile subglobose receptacle covered with short appressed hairs, and from the latter by the thinner caudate leaves slightly hairy below and the subsessile subglobose and hairy receptacle.

Hemsley based his species mainly on Henry's no. 8716 from Hainan which has to be considered the type of his species and is the plant figured on the plate except figure 7 representing a single receptacle which is from Faber's no. 446 and apparently belongs to *F. Esquirolii*. The description also applies mainly to the Hainan plant if under "Reptacula" the words "subsessilia vel . . . vel sphaeroidea . . . vel leviter puberula" are taken out.

Typical *F. stenophylla* is represented in this herbarium by plants from Hainan (W. T. Tsang no. 378, McClure, no. 9584), Kwangtung (C. L. Tso, no. 21048, Levine & Kwok, no. 875), Fukien (L. Y. Tai, no. 11673), Chekiang (R. C. Ching, no. 1692) and from Kweichou (Steward, Chiao & Cheo, no. 877); the last named specimen seems to approach *F. Esquirolii* in the shorter stalk of the receptacle. *Ficus Esquirolii* is represented besides by the photograph of the type also by Handel-Mazzetti, no. 10695, Y. Tsiang, no. 6053 and Steward, Chiao & Cheo, no. 147, all from Kweichou.

Under *Ficus Esquiroliana* Léveillé (in Bull. Geog. Bot. **24:** 252) says of *F. Esquirolii* "extra genus probata est" but he still enumerates it the following year in his Flore du Kouy-Tchéou as *F. Esquirolii*, while he changes *F. Esquiroliana* to *F. laus-Esquirolii*.

Ficus silhetensis Miquel in Ann. Mus. Bot. Lugd.-Bat. **3:** 223, 291 (1867). — Léveillé, Cat. Pl. Yun-Nan, 275 (1917).

Ficus Cyanus Léveillé & Vaniot. — Rehder in Jour. Arnold Arb. **10:** 129 (1929) — **Synon. nov.**

Ficus Cyanus var. *viridescens* Léveillé & Vaniot in Mem. Acad. Ci. Art. Barcelona, ser. 3, **6:** 149 (Ficus Spec. Chin. 11) (1907); in Fedde, Rep. Spec. Nov. **4:** 84 (1907).

Ficus congesta Léveillé & Vaniot in Léveillé, Fl. Kouy-Tchéou, 429 (1915). — Rehder in Jour. Arnold Arb. **10:** 128 (1929). — **Synon. nov.**

CHINA. Kweichou: Si-liéou-gay, trous profonds, *J. Cavalerie*, no. 169, July 3, 1902 (holotype of *F. Cyanus;* merotype in A. A.); arrivée à Tong-kai (ruisseau), *J. Esquirol*, no. 3031, July 25, 1911 (cited in Fl. Kouy-Tchéou under *F. Cyanus;* photo. and duplicate in A. A.); Pin-fa, *J. Cavalerie*, no. 1099, June 23, 1903 (holotype of *F. Cyanus* var. *viridescens;* photo. in A. A.); Tché-chou, bois, *J. Esquirol*, no. 2506, Sept. 1909 (holotype of *F. congesta;* merotype in A. A.).

Ficus Cyanus differs slightly from *F. silhetensis* as figured and de-

scribed by King (in Ann. Bot. Gard. Calcutta, **1**: 154, pl. 194, 1888) in the shorter petioles and cuneate base of the leaf, but otherwise agrees. The variety *viridescens* does not seem to differ from typical *F. Cyanus*, and in Flore du Kouy-Tchéou, Léveillé enumerates it under the species. *Ficus congesta* resembles closely Cavalerie's no. 1099 (*F. Cyanus* var. *viridescens*) except that the leaves are somewhat smaller.

The species has also been collected in Kweichou by Y. Tsiang, no. 4404, determined as *F. silhetensis* Miq. by E. D. Merrill.

Ficus Stapfii Léveillé. — Rehder in Jour. Arnold Arb. **10**: 131 (1929).

Ficus Stapfii is represented only by a sterile specimen (photo. and fragments in A. A.). It was referred by Handel-Mazzetti (Symb. Sin. **7**: 100) tentatively to *F. heteromorpha* Hemsl., but differs in its rather dense pubescence; in this respect it resembles *F. silhetensis* Miq., but the leaves are oblong and obtusish to acutish, not acuminate at the apex.

Ficus Abelii Miquel in Ann. Mus. Bot. Lugd.-Bat. **3**: 281 (1867).

Ficus Schinzii Léveillé & Vaniot in Fedde, Rep. Spec. Nov. **8**: 550 (1910). — Léveillé, Fl. Kouy-Tchéou, 433 (1915). — Rehder in Jour. Arnold Arb. **10**: 131 (1929). — Non *F. Schinziana* Warb. — **Synon. nov.**

China. Kweichou: Lo-fu, *J. Cavalerie*, no. 3592, Apr. 1909 (holotype of *F. Schinzii;* merotype in A. A.); Tsao-ly, bord de rivière, alt. 600 m., *J. Esquirol*, no. 3503, Feb. 5, 1912 (cited in Fl. Kouy-Tchéou; duplicate in A. A.).

By Handel-Mazzetti (l.c. 100) *F. Schinzii* was referred to *F. pyriformis* and its allies. It certainly belongs to *F. Abelii* which has not yet been recorded from Kweichou, though it has been collected in Szechuan and Hunan.

Ficus Roxburghii Wallich. Num. List. 4508 (1832). — Handel-Mazzetti, Symb. Sin. **7**: 100 (1929).

Ficus macrocarpa Léveillé & Vaniot in Mem. Acad. Ci. Art. Barcelona, ser. 3, **6**: 152 (Ficus Spec. Chin. 14) (1907); in Fedde, Rep. Spec. Nov. **4**: 85 (1907). — Léveillé, Fl. Kouy-Tchéou, 431 (1915), sub *F. macrocarpa* Wight. — Rehder in Jour. Arnold Arb. **10**: 130 (1929). — Non Wight.

China. Kweichou: without precise locality, *J. Cavalerie* in 1899 (holotype of *F. macrocarpa;* ex Léveillé); ouest de Lo-fou, *J. Cavalerie*, no. 3593, March 1909, "bel arbre" (cited in Fl. Kouy-Tchéou; photo. in A. A.).

Handel-Mazzetti refers to *F. Roxburghii* besides *F. macrocarpa* also *F. Letaqui* Lévl. & Vant. which see below.

Ficus Roxburghii Wall. must be considered a valid publication of a new name, since he cites as a synonym "*F. macrophylla* Hb. Roxb. (haud Desf.)" a species described in Roxburgh, Fl. Ind. **3:** 556 (1832).

Ficus Letaqui Léveillé & Vaniot in Fedde, Rep. Spec. Nov. **8:** 550 (1910). — Léveillé, Fl. Kouy-Tchéou, 531 (1915). — Rehder in Jour. Arnold Arb. **10:** 130 (1929).

This species was referred by Handel-Mazzetti (Symb. Sin. **7:** 100) to *F. Roxburghii,* but it differs markedly from *F. Roxburghii* in the much smaller subglobose and subsessile receptacles, borne mostly in pairs on the nodes of long and slender leafless shoots; the leaves are similar in shape, but scabrid above and borne on longer and slenderer petioles.

Ficus Vanioti Léveillé, Fl. Kouy-Tchéou, 434 (1915), pro parte.

CHINA. Kweichou: bois sacré au Che-chen de Na-é, *J. Esquirol,* nos. 3077 and 3078, end of June and July 1 (syntype of *F. Vanioti;* photo. in A. A.).

The name *F. Vanioti* was published in Flore du Kouy-Tchéou with *F. ouangliensis* as a synonym and was intended apparently as a new name for that species which is based on Cavalerie no. 2568, and is not a *Ficus,* but an *Aglaia.* The two specimens cited above, however, represent a species of *Ficus,* but the material is so fragmentary, consisting only of bare branches, broken leaves and a few broken receptacles, that exact identification is not possible; the material seems to belong in the affinity of *F. formosana* Maxim.

LORANTHACEAE

Tolypanthus Maclurei (Merr.) Danser in Bull. Jard. Bot. Buitenzorg, ser. 3, **10:** 355 (1929).

Loranthus Maclurei Merrill in Philipp. Jour. Sci. **21:** 494 (1922).

Loranthus Esquirolii Léveillé, Rev. Ann. Chine, **1916:** 21 (MS). — Nomen non rite publicatum.

CHINA. Kweichou: Pin-fa, Heou-tcheng, *J. Esquirol,* no. 52, "liane parasite sur le bibassier" (type of *Loranthus Esquirolii;* photo. in A. A.).

Léveillé's name *Loranthus Esquirolii* appeared in a manuscript publication, of which only a few copies were distributed and cannot be considered validly published; Merrill's specific epithet therefore, remains valid. The name *Loranthus Esquirolii* does not appear on the original label of the type specimen which was identified by Danser as *Tolypanthus Maclurei.*

(To be continued)

HERBARIUM, ARNOLD ARBORETUM,
HARVARD UNIVERSITY.

CHROMOSOME NUMBERS AND PHYLOGENY IN THE GYMNOSPERMS

WALTER S. FLORY

With two text figures

CRITICAL STUDIES of chromosome morphology in most groups of living gymnosperms have been published during the past few years. Geitler (1929) and Florin (1932) have described the chromosomes of *Welwitschia* and *Ephedra* of the order Gnetales. Sax and Beal (1934) investigated the chromosome situation in all nine genera of the Cycadales. The most comprehensive chromosome survey in the gymnosperms is that of the Coniferales by Sax and Sax (1933). Fifty-three species from sixteen genera of the subfamilies Cupressineae, Taxodineae, Abietineae, and Taxineae were studied. The sole surviving member of the Ginkgoales was included in the last mentioned analysis and has been the object of cytological studies by other workers as well. This leaves only the subfamilies Araucarineae and Podocarpineae and the genus *Gnetum* with representatives unanalyzed in recent cytological papers. With regard to two of these groups Sax and Beal (1934) write, " . . . recent studies indicate that *Podocarpus* has 20 pairs of chromosomes"; and, also " . . . *Gnetum* has a large number of relatively small chromosomes." In earlier accounts Burlingame, Ishikawa and Schurhoff (from Sax and Sax, 1933, p. 368) have found 12 chromosomes in several species of *Podocarpus*.

Only two genera are included in the subfamily Araucarineae. They are *Araucaria* and *Agathis*. An early morphological study (Lopriore, from Coulter and Chamberlain) on one species of *Araucaria* indicated the presence of 12 pairs of chromosomes here. No references have been found to critical chromosome work on either genus of this subfamily. Questions concerning the phylogenetic sequence of conifer subfamilies involve the Araucarineae at important points. One question concerns the comparative antiquity of the Araucarineae and Abietineae; another the relationship between the Araucarineae and the Podocarpineae. This investigation was made to see if a knowledge of chromosome number and morphology in the Araucarineae would aid in solving problems of the nature mentioned. To further that end, the chromosomes of several species of *Podocarpus* have been examined, and the results obtained will be briefly discussed.

Material for this work has been secured from several sources. The greenhouses of the Bussey Institution, the Arnold Arboretum, and the Biological Institute of Harvard University, have been sources of some species of *Agathis* and *Araucaria*. Root tips of two species of *Podocarpus* and of two species of *Araucaria* were obtained at Wellesley College. Other material of *Araucaria* and *Podocarpus* was collected at the Brooklyn Botanic Garden and at the New York Botanical Garden. We realize that the species names of such specimens may not be correct, but it was not possible to verify the classification of these immature plants.

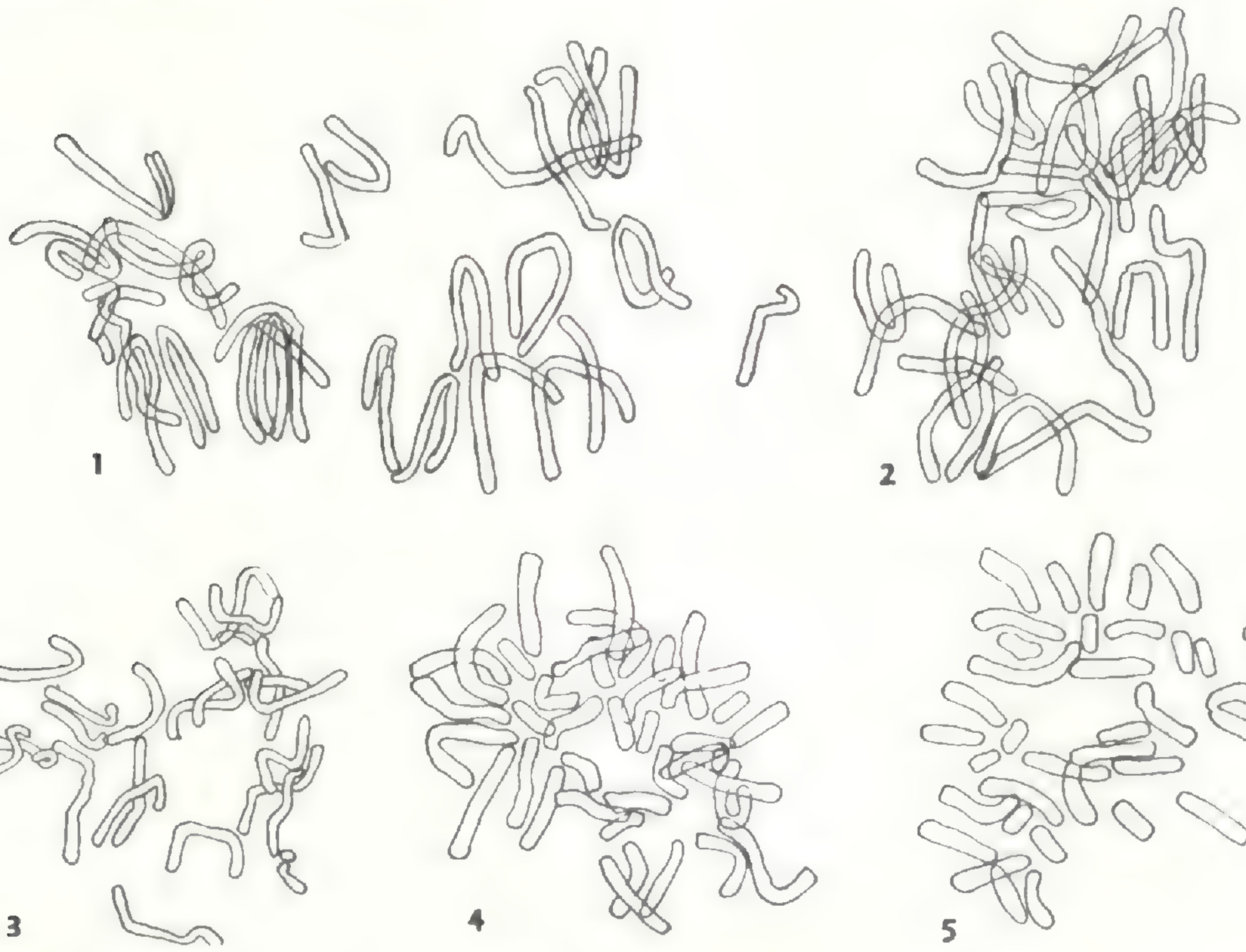
Absolutely accurate chromosome counts of conifer species are difficult to secure in root tip cells, — endosperm material being much preferred for preparations of somatic chromosomes. However, root tips were the only material available for the present study. The chromosomes of all species examined were studied in aceto-carmine smears of root tip cells. Some recent advances in technique allow somewhat more critical preparations to be made than were formerly possible. A modification of Warmke's (1935) method of making temporary root tip smears was used. Root tips were fixed in aceto-alcohol overnight; treated with a hydrochloric acid and 95% alcohol mixture; hardened in aceto-alcohol; then sliced and macerated. After the preparations had been allowed to stand for from 5 to 15 minutes, they were heated almost to boiling; then considerable pressure was exerted upon the cover glass, and this was followed by a second heating, after which the mounts were sealed. By this method metaphase plates were secured, in several species, in which the chromosomes were well scattered, enabling them to be readily counted.

Rehder's (1927) classification has been followed with regard to division of the Coniferales, and elsewhere when possible. This has been supplemented by use of Pilger's (1926) classification for the forms not generally grown in the temperate United States.

DESCRIPTION

Agathis robusta, *Araucaria brasiliana*, and *A. Cunninghamii* each contains 13 pairs of chromosomes. Material from a plant of *Agathis* bearing a doubtful specific name also showed 26 somatic chromosomes. Numerous plates from *Araucaria Bidwilli* were also studied. The chromosome picture appeared to be identical with that found in the other two species of *Araucaria* studied. Counts of a number of metaphase figures seen in side view indicated the presence of 26 somatic chromosomes in this species. The chromosomes of species belonging to the same genus were very similar. The chromosomes of *Agathis robusta* (Fig. 1) and of *Araucaria brasiliana* (Fig. 2) were studied in more detail than those of the other

species. In each of these species there were 9 pairs of chromosomes in which the arms were about equal in length, or in which the longest arm was, at most, not twice the length of the shortest. In addition to these chromosomes with median or submedian attachments, both species apparently have 4 pairs with nearly terminal attachment points. The chromosomes of *Agathis* and *Araucaria* are similar not only in morphology but also in size. Chromosomes of *Agathis*, in aceto-carmine, vary in length from 13 μ to 22 μ; those of *Araucaria* from 12.5 μ to 20 μ. In *Araucaria* the elements appear to be slightly greater in diameter than in *Agathis*, but the difference is too small to be significant.



TEXT FIGURE 1

Drawings of chromosomes of root tip cells. × 900. Fig. 1. *Agathis robusta*, 26 chromosomes. Fig. 2. *Araucaria brasiliana*, 26 chromosomes. Fig. 3. *Podocarpus falcatus*, 24 chromosomes. Fig. 4. *Podocarpus macrophyllus*, 38 chromosomes. Fig. 5. *Podocarpus neriifolius*, 36 chromosomes.

The chromosomes of five forms of *Podocarpus* were examined. These were *P. macrophyllus*, *P. falcatus*, *P. neriifolius*, *P. chinensis*, and *P. andinus*. Pilger indicates that *P. chinensis* is merely a form of *P. macrophyllus*, which is cultivated in botanic gardens, and is not a separate species. The first four forms listed belong in the generic section Eupodocarpus. *Podocarpus andinus* is placed in Pilger's section Stachycarpus.

In these five forms there are two different types of genoms. The first type of genom was found in a species growing in the greenhouse at Wellesley College and tentatively identified by Dr. Alice Ottley as *P. fal-*

catus R. Br. Several plates quite clearly showed 24 chromosomes in root tip cells of this plant (Fig. 3). These plates, quite apparently, were almost complete. Each, however, had its elements quite scattered, owing to pressure; and it is possible that a few chromosomes were lost. Of the 24 chromosomes observed, 2 pairs were approximately isobrachial; the other 10 pairs were distinctly heterobrachial. Chromosome measurements were, for the longest, 15 μ; for the shortest, 5.5 μ; and the average length was approximately 11 μ. In morphology the complement is similar to that found in many conifers. However, the chromosomes are smaller than those found in most species.

In *P. macrophyllus* many plates were found which showed all but a few chromosomes distinct and unentangled (Fig. 4), but no complete plate was beyond question at some point. The number is about 38, many plates seeming to have this count. In several cases there was a suggestion of 39 chromosomes. No plate seemed to have 40 but perhaps, for safety, the number should be placed as between 38 and 40. The best figures, those appearing to contain 38 elements, were analyzed. Ten pairs are heterobrachial, 3 of these approaching the isobrachial condition. Nine pairs appear to have attachment points that are terminal, or very nearly so. Chromosome measurements give, for the longest pair, 12.5 μ; for the shortest, 3.5 μ; and the average length was about 7.5 μ.

The *P. neriifolius* complement has much the same appearance as that of the species just described. Approximately 38 chromosomes are present. However, the majority of these appear terminal or nearly so, the only apparent exceptions being one short isobrachial pair, and the longest pair, which have submedian attachment constrictions. The longest chromosomes are 12.5 μ, the shortest 3 μ. Figure 5 shows 36 well-spaced chromosomes in a plate from which a few have been lost.

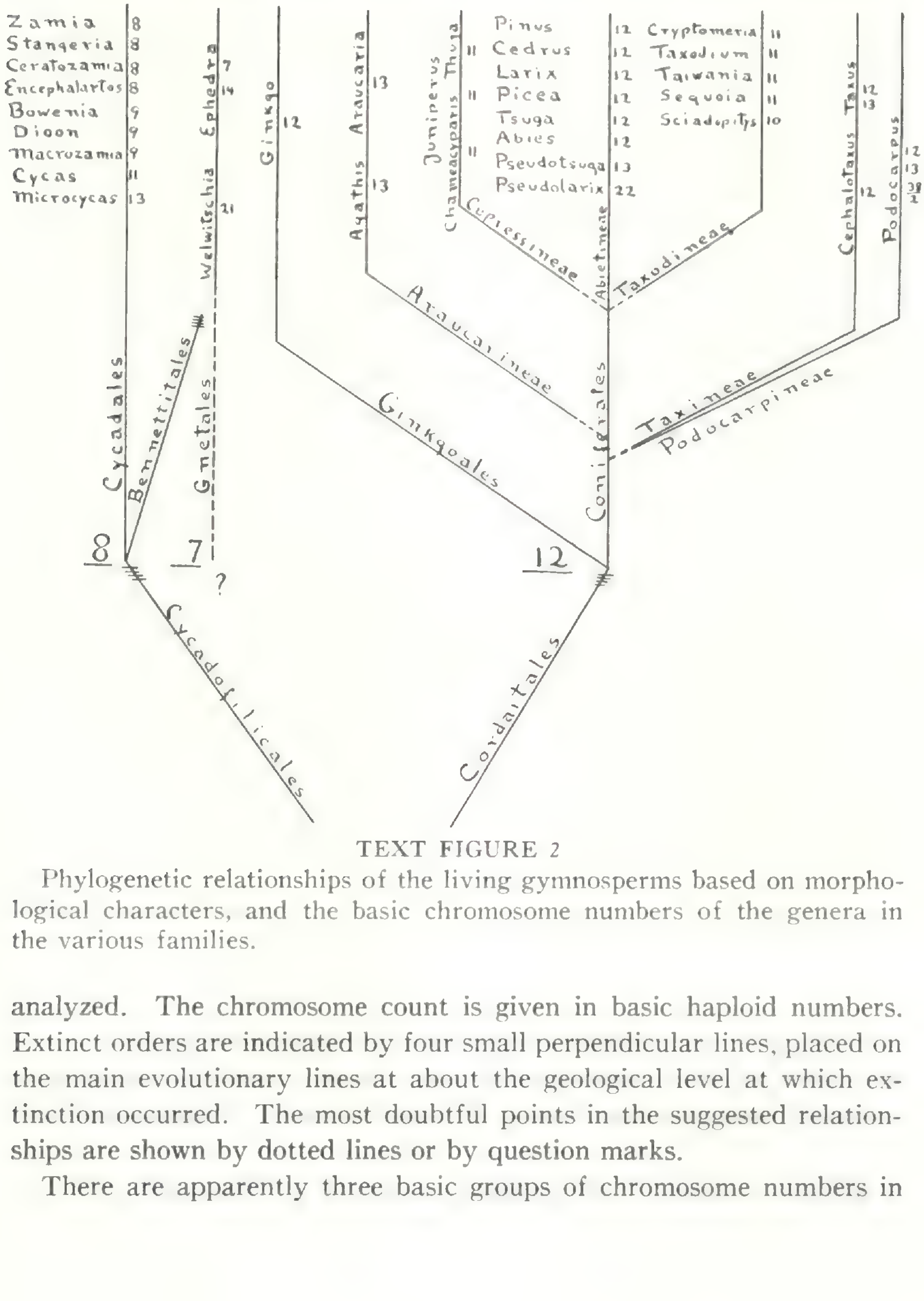
Podocarpus chinensis and *P. andinus* (belonging to a different section from the other podocarps mentioned here) were seen to have the same general type of complement as *P. macrophyllus*, having nearly 40 chromosomes, many with terminal or near terminal attachment points.

CHROMOSOME NUMBERS AND PHYLOGENY

Numerous morphological studies have been made on gymnosperms. These, with discussions of suggested evolutionary tendencies, are best summarized by Chamberlain (1935 a and b). A diagram (Text fig. 2) representing the phylogeny of gymnosperm orders and families, as represented by the best available evidence, has been made. In this diagram ideas and material from a number of sources (chiefly: Chamberlain, 1935b, diagram p. 184; Jeffrey, 1917, especially pp. 355–6; Sax and Sax,

l. c.; Sax and Beal, l. c.; Florin, l. c.; Matsuura and Suto, 1935; and the present work) are incorporated in one figure. Since representatives of all major gymnosperm groups have now been subjects of critical cytological examination, it seemed appropriate that some effort be made to see how the cytological facts fit in with those of grosser morphology.

A description of Text figure 2 follows. Beneath each major division are placed its genera from which representatives have been cytologically



TEXT FIGURE 2

Phylogenetic relationships of the living gymnosperms based on morphological characters, and the basic chromosome numbers of the genera in the various families.

analyzed. The chromosome count is given in basic haploid numbers. Extinct orders are indicated by four small perpendicular lines, placed on the main evolutionary lines at about the geological level at which extinction occurred. The most doubtful points in the suggested relationships are shown by dotted lines or by question marks.

There are apparently three basic groups of chromosome numbers in

the living gymnosperms. The basic numbers are predominantly 8 or 9 for the Cycadales, 7 for the Gnetales, and 12 for the Ginkgoales and Coniferales. The deviations from these basic numbers in these groups can be attributed to elimination of one or several chromosomes following segmental interchange or polyploidy, and an increase in chromosome number resulting from fragmentation or chromosome duplication. Polyploidy is rare in the gymnosperms. The chromosomes of species of gymnosperms are much more uniform in number, size, and general morphology than those in the species of angiosperms.

The count of 38 somatic chromosomes in certain species of *Podocarpus* at first suggested a basic number of 19. This is the basic number in certain primitive angiosperms, and Anderson (1934) has suggested an allopolyploid origin of such angiosperms from primitive gymnosperms with basic chromosome numbers of 7 and 12. The presence of about 12 pairs of chromosomes in one species of *Podocarpus* suggests, however, that the forms with about 38 somatic chromosomes may be triploids with 13 chromosomes as the basic number, or that chromosome fragmentation at the fiber attachment point has effected the change in these genoms.

The cytological analysis of the Coniferales seems to show some correlation with the morphological evidence regarding family relationships. The Cupressineae and Taxodineae have the same basic chromosome numbers. The basic chromosome number is 13 in the Araucarineae and is 12 or 13 for the Podocarpineae. The presence of 12 chromosomes in most genera of the Abietineae supports the theory that this may be the main line from which the other families have been derived. The basic number of 12 chromosomes in the Ginkgoales also supports the suggestion that 12 is the basic number from which both families, Taxaceae and Pinaceae, originated.

SUMMARY

The basic chromosome number is 13 for *Agathis* and *Araucaria*, and the genoms are similar in morphology. Chromosome numbers were obtained in five species of *Podocarpus*. In one species about 24 somatic chromosomes were counted, but in the other species there were about 38 chromosomes in the root tip cells. The basic chromosome number is 12 or 13, and the four species with about 38 chromosomes presumably are the result of polyploidy or chromosome fragmentation.

A survey of chromosome numbers in the gymnosperms indicates three basic numbers, — 8 or 9 for the Cycadales, 7 for the Gnetales, and 12 for the Ginkgoales and Coniferales. There is some correlation between

chromosome numbers and morphological relationships of the various taxonomic units.

This work was done at the Bussey Institution of Harvard University while the author was a National Research Council Fellow.

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APOSPORIC PARTHENOGENESIS IN A TRIPLOID APPLE, MALUS HUPEHENSIS

HAIG DERMEN

With plates 179–181

A NUMBER of years ago Dr. Karl Sax, in his attempt to make intergeneric crosses in Pomoideae, found that whenever *Malus hupehensis* was used as the female parent, seeds were always formed. Preliminary experiments were made to discover the basis of this peculiarity (Sax, 1931) and it was found that this species behaved as a typical parthenogenetic plant. I was designated to investigate the problem and the present report is a cytological analysis of this phenomenon.

Malus hupehensis (Pamp.) Rehd. (*M. theifera* Rehd.) (Rehder, 1933) is known to be a pure species, distributed widely in mountain regions of China extending south into Assam. It was introduced into this country in 1900. All plants of this species growing in the Arnold Arboretum, some of which have been propagated from seeds here and some brought in from outside sources, fruit heavily; the fruits containing the usual number of seeds. All the seeds appear to be deformed in outline in comparison with those of other species.

MATERIAL AND METHODS

In order to have a sounder basis for our conclusions concerning parthenogenetic behavior in *M. hupehensis* it was thought advisable to make parallel observations on another species, the embryonic development of which was normal. *Malus arnoldiana* (Rehd.) Sarg. (*M. baccata* × *floribunda*), a hybrid, chosen as a control plant, produces an abundance of fruit, and normal seeds in contrast to *M. hupehensis*.

In the summer of 1931 a preliminary examination was made of the chromosome number from root-tips of a *M. hupehensis* seedling and it was found to be a triploid form. The analysis of the ovules was made beginning the first week of May and continuing through the summer during the years 1932, 1933 and 1934. The study of this problem during the first two years was exploratory in character and it was in 1934 that a more complete analysis of the ovules of both *M. arnoldiana* and *M. hupehensis* was made.

Specimens at different stages of ovular development were fixed separately. The fixing of material was begun during the first week of May

when the buds began to turn pink and the development of the female meiotic phase was initiated. This phase is completed just before shedding of petals when the egg apparatus in the embryo sac (ES) is formed and fertilization has taken place (normally). From the pink stage to the time of shedding of petals six separate collections were made. Two collections were made between shedding of petals and remaining parts of perianth. After that the collections were continued at 5 to 7 day intervals in order to follow up the sequence of embryo development.

In fixing material for early stages, the fleshy part of the ovary is trimmed off with a sharp knife in order that the fixative may penetrate the ovules quickly. For later stages young seeds are removed from the fruit and are fixed directly. For quick penetration of fixative in older seeds the seed coat may be slightly slashed. For more mature seeds the whole testa may be removed.

The first year Flemming's solution was used as fixative but was found unsuitable for this material. Navashin's solution was found preferable for the meiotic and earlier stages of embryo sac formation. However, being doubtful of the effect of the latter fixative on later stages, Lewitzky's solution (5% formalin and 0.5% chromic acid) was used for those, since I had found earlier (Dermen, 1933) that it facilitates at least the staining of nucleoli with either crystal violet-iodine or haematoxylin. In this way I hoped to have at least the nucleoli to go by as landmarks, so to speak, in determining the nuclear number and other features in the development of embryo sacs. The results eventually showed this assumption to be justified. To prevent severe distortion of embryo sacs in changing fixed material into alcohol for paraffin sectioning, the material was allowed to remain in the fixative for twelve hours or more, washed in water and run up in alcohol gradually beginning with 5%. The results later showed that there was some shrinkage of the embryo sac and endosperm layer away from the nucellar tissue, though not enough to make observations confused.

Paraffin sections of early stages to the beginning of ES formation were cut 20 μ thick and from ES formation on up 35–40 μ, thick enough to obtain whole embryo sacs and young embryos, in order that confusion might be avoided in studying the origin and sequence of development.

Meiotic stages were stained with crystal violet-iodine, and ES and later stages with haematoxylin. Root-tips were fixed in Lewitzky's solution and stained with crystal violet-iodine; while for meiosis in the anther aceto-carmine technique was used.

Due to technical difficulties in illustrating various phases, it was necessary to use different scales. The scale used is indicated under each drawing.

DESCRIPTION

The features illustrated which were considered important in the analysis of parthenogenetic behavior in *M. hupehensis* are presented in 38 figures in three plates. The drawings are made in diagrammatic form to bring out the points pertinent to this study and to give the most essential details of origin and development of both embryo sac and embryo. The comparative illustrations of the control plant, *M. arnoldiana*, and *M. hupehensis* run from Figs. 18 and 19 to Figs. 34 and 35 inclusive. Other figures are from *M. hupehensis* alone.

The somatic chromosome number in *M. hupehensis*, studied from root-tips, was 3n = 51 (Fig. 1), a triploid number, the diploid being 2n = 34. The next figure (Fig. 2) represents the chromosome set from a tetraploid seedling of *M. hupehensis* with 4n = 68, the discussion of which will be found elsewhere in this paper. The size of these chromosomes is about one micron in length.

The meiotic development in anthers took place about 10 days earlier than the corresponding phase in the ovules. In the anthers the homologous chromosomes form trivalents and bivalents and a few remain univalents (Sax 1932). Figure 3 is II M from anthers with 25± chromosomes at each plate. No mature pollen grains are found in the anthers. Some cells begin to degenerate at I M and others at later stages, and most degenerate after they have reached the tetrad stage when the individual microspores fail to break apart although they are fully differentiated and each has its own wall.

A similar process of degeneration was found in the ovules. Here the chromosomes either remain univalents at I M or pair variously and divide at random. Figure 4 (a and b) represents I M in an egg mother cell (EMC). The chromosomes here are in univalent form. In the two sections, a and b, the total is exacly 51. It cannot be stated with certainty when, if ever, in univalent form there was any division in the EMC. However, in a few instances observed where the chromosomes were unpaired the cell was in a stage of degeneration. Such a cell is shown in Fig. 11. An anaphase stage is given in Fig. 5 (a and b). The b group of chromosomes from the lower pole was in a following serial section. Here also the total number of chromosomes could be accurately counted.

Altogether in *M. hupehensis* over two hundred ovules in the early stages of meiosis were examined and only rarely were there found ovules lacking a meiotic cell, either in prophase, in division stages, or in a degenerative process. There were found some older ovules which lacked embryo sacs. One young ovule was found with two egg mother cells.

There were observed many ovules divided into two nucellar regions, a twin ovule, each with a simple or a compound ES, enclosed together within a common integument.

An EMC is shown in Fig. 6 at pachytene stage. Usually around a meiotic cell there are one or more somatic cells each with a nucleolus as large or larger than that in the meiotic nucleus, which, as will be pointed out later, may develop into embryo sacs. Very rarely there were found ovules with two egg mother cells. Such a case is shown in Fig. 7. Around these meiotic cells are found a number of large nucleolated somatic cells. Figure 9 is a small scale drawing of the same cell to indicate the distance of a meiotic cell from the upper end of the nucellus. Here the EMC is 6 cell layers deep, while in other ovules the number of layers may vary. In *Lilium regale* (original observation) this layer was always one layer deep from an early stage to the time of fertilization (later stages were not observed). Figure 10 illustrates a typical young ovule with two layers of integumental tissue as it appears in longitudinal section. The cell in it is the same as in Figs. 8 and 9. The tissue around this cell is the nucellus. This figure shows the approximate location of the EMC in the ovule taken as a whole.

As was mentioned above the EMC may either degenerate at I M or later as in the anther. A degenerating cell at I M is shown in Fig. 11. Here the cell was found compressed from the sides and the chromosome stain was blurry showing these bodies more or less clumped together. As a whole its degenerated feature could be easily distinguished when compared with other cells at the same stage. As well as could be made out the chromosomes in this cell were not paired, which fact, I believe, may be correlated with degeneration of the cells at this stage.

Figures 12 and 13 show a parallelism in division with EMC and in development of one of the resulting cells into, supposedly, an ES. Normally an EMC should divide twice and from this division four cells should result. One of these, which is the furthest from the micropyle should be the megaspore destined to become an ES. However, as will be shown below, this expectation is not fulfilled in *M. hupehensis*. In Fig. 12 we find three cells. The one nearest to the micropyle has degenerated. This cell corresponds to one in Fig. 13 which was in metaphase and in a stage of degeneration. In this latter figure the second division was found to be irregular; some of the chromosomes at opposite poles were at a distance from the main chromosome groups. If this cell divided it would result in two unequal sized cells, because these two groups of chromosomes are not found at equal distance from the ends of the cell. This is what is found in Fig. 12. Here one cell is degenerating.

One of the sister cells from the second division is small, the other large, and in this large cell there is a small chromosome mass outside the main nucleus, indicating that this cell is not an ordinary somatic cell but the product of an irregular second division of an EMC.

Direct as well as indirect evidence shows that meiotic cells at some stage of their development degenerate while somatic cells in their immediate vicinity usually grow in size and develop into embryo sacs. Figure 14 illustrates this point clearly. Here is shown a rather large somatic cell with a large nucleolus, above which there is a meiotic cell in a stage of degeneration. In Fig. 15 is shown such a cell that has grown in size. The nucleus has divided and the cell is in a two-nucleate stage and beginning to develop into an ES. At the base of this are shown four cells in a row that have annular xylem thickenings, an unexpected manifestation in an ovule, this type of cell being characteristic of vegetative tissues. Similar cells were found at later stages of ES development and in one case in a complex ES. Serial sections from either side of this were scrutinized and no trace of degenerating meiotic cells was found in the neighborhood of this binucleate ES. Therefore, it may be that these four annulated cells represent the tetrad resulting from two meiotic divisions. Their degeneration was expressed by transformation into xylem elements. Such cases were found only in 1932 material.

In the majority of cases the embryo sacs were structurally complex. These were found to have resulted from the fusion of two or more embryo sacs. A simple case is shown in Fig. 16 where two embryo sacs were found growing simultaneously. In other cases the number of these young embryo sacs growing side by side may reach six or more. In this figure one is four-nucleate and the other below it two-nucleate. In Fig. 23 two adjacent sacs are shown in mature egg apparatus stages. Figure 17 represents the middle section of five serial sections in which a total of 30 nuclei could be counted which may have resulted from fusion of four embryo sacs, boundaries of which could not be made out clearly.

Illustrations from Fig. 18 to Fig. 35 inclusive are diagrammatic representation of comparative development of embryo sacs and embryos in *M. arnoldiana* and *M. hupehensis*. Figures 18 and 19, the former from *M. arnoldiana* and the latter from *M. hupehensis*, are from material fixed at the time of full bloom. Both represent the stage when the embryo sacs have completed the cycle of the development with three antipodal nuclei cut off, each having formed a separate small cell. The main portion of the ES now functions as a distinct body in which there is an egg cell with two synergid cells together forming the egg apparatus, below which the two polar nuclei have approached each other but com-

plete fusion is delayed, perhaps till joined with a sperm. A similar situation was observed in *Lilium regale* (original observation) where first the upper polar nucleus is joined with a sperm and these two jointly meet half way with the lower polar nucleus. By the time of fertilization the egg cell is larger than the synergids (Fig. 20, *M. arnoldiana*). In these drawings the upper limits of the egg and synergid cells are not shown because they were vague in my preparations. In Fig. 19 (*M. hupehensis*) a dotted nucleolus of one of the polar nuclei and a dotted synergid cell are superimposed on the main portion from an adjacent section in a single drawing. The outer broken line represents the inner limit of the nucellus. A more mature ES is shown in Fig. 20 of *M. arnoldiana* from material fixed at the time of calyx shedding (the last remnant of the perianth with dried up styles). Here only nucleoli are shown. At this stage the antipodal cells had disappeared and the sac had grown longer but not much wider. At this time of the ES development fertilization has usually taken place, but perhaps due to climatic conditions some cells remain unfertilized. In the ES shown in Fig. 21 (*M. arnoldiana*) there is a clear indication that fertilization has taken place, judging by the amount of nucleolus in the egg nucleus in comparison with the same in the synergids. In the other figures (Figs. 18–20, taking these individually) the size of the nucleoli in the egg and the synergids is remarkably similar. Fertilization in Fig. 21 is further indicated by the fact that there appears the beginning of endosperm nuclear division, due to fusion of the polar nuclei with a male gamete.

The embryo sacs shown in Figs. 22, 23 and 24, all of *M. hupehensis*, are from material fixed at the time of calyx shedding as in Figs. 20 and 21 of *M. arnoldiana*. These five figures are drawn to the same scale. In all the antipodals have disappeared. Judging from the size of the nucleoli of the cells in the egg apparati in the three figures (22, 23 and 24), as in Fig. 20 pointed out above, there is no indication of fertilization and these cells will remain unfertilized since the fruits at this time are quite advanced and the styles have long since dried up and dropped off with the remaining part of the perianth. In Fig. 22 we see the beginning of endosperm formation after, perhaps, polar nuclei have fused together and divided without being fertilized. The egg cell grows larger, its nucleus moves to the tip of the cell, the synergids eventually disappear and long after there sets a cell division at the tip of the egg cell. From now on the ES begins to grow lengthwise and extends through the nucellar tissue in a manner similar to pollen tube growth. The nucellar cells in the neighborhood of the sac begin to break down, undoubtedly due to some sort of enzymic action, offering no resistance

to the tubular growth of the ES. In Fig. 23 we find two embryo sacs side by side. The missing parts of these are given at the side of the twin sacs drawn from an adjacent section. Here a fused polar nucleus is shown under one of the cells of the egg apparatus, indicating that polar nuclei may fuse before the endosperm development is set. Figure 24 represents a single ES; one of the cells shown at the side is drawn from an adjacent section.

Tubular growth of the ES in *M. arnoldiana* is in proportion to the embryo growth. About a week after fertilization the number of cells in longitudinal section of the embryo is about six. At this time the tip of the ES is ½ to ⅔ the length of the nucellus. In *M. hupehensis*, when the ES is a derivative of only one somatic cell, the width of the sac is about the same as that of *M. arnoldiana*, but in the great majority of the ovules examined, the ES has grown disproportionately wider and deeper in the nucellus after reaching its basal limit, independently of the amount of endosperm as well as embryo growth which at this time may still be in the one cell stage. This is undoubtedly due to the compound nature of the ES, as shown for example in Figs. 17 and 23. Figure 25 represents a very young embryo (proembryo) of *M. arnoldiana* about two weeks after fertilization. At this time the number of cells in the proembryo in longitudinal section averages ten. The tip of the ES has barely reached the lower limit of the nucellus. Figure 26 shows diagrammatically this stage. The broken line in this figure indicates the extent and the limit of the ES while the dotted line at the base shows the basal tissue which is firm and not penetrated by the ES. In Fig. 27 is shown the beginning of proembryo formation in *M. hupehensis*, two weeks after shedding of petals.

The embryo development in *M. arnoldiana* is regular and rapid compared with that of *M. hupehensis*. About three weeks after fertilization the proembryo in *M. arnoldiana* differentiates into a suspensor and a true embryo (Fig. 28). In this figure the endosperm, composed of a uninucleate layer, is separated from the nucellar tissue due to shrinkage from fixation. In *M. hupehensis*, if any embryo development is initiated, the embryos are still in proembryonic form at a corresponding period. Such a stage is shown in Fig. 29. This drawing represents a compound ES in which two proembryos were found, one at the micropylar corner and the other in the free space, away from the nucellus, each undoubtedly belonging to a separate ES, the limits of which cannot be easily distinguished. A four weeks old embryo of *M. arnoldiana* is illustrated in Fig. 30 showing the suspensor, the true embryo and more extended growth of endosperm tissue, the broken line indicating its limit of growth.

The central region of the ES is still devoid of this tissue. In *M. hupehensis*, four weeks from the time of flower shedding, the proembryo is still undifferentiated. Such a stage is illustrated in Fig. 31. In this case a single proembryo was found in the middle of a complex ES. Eventually other embryos may develop in the same sac. This particular ES was chosen for illustration merely to indicate that in *M. hupehensis* embryos develop, as seen in prepared material, directly from the ES and never from any other tissue surrounding or near the ES; otherwise, more often, the embryos are located at or near the micropylar corner. Figure 32 represents a six weeks old embryo in *M. arnoldiana* when the cotyledons begin to differentiate. The broken line indicates the limit of a dense endosperm layer next to the nucellar tissue. This layer seems to separate the suspensor from the nucellus and extend between these. The embryo is imbedded in looser endosperm. Figure 33 shows the stage of embryo development in *M. hupehensis* six weeks from flower shedding. Here there is the beginning of differentiation of the proembryo into a suspensor and a true embryo with few endosperm nuclei in the sac. Figure 34, drawn to a smaller scale, shows a five weeks embryo from a wide view of the cotyledon in *M. arnoldiana*. The broken line shows the limit of the dense endosperm, the embryo being imbedded in loose endosperm. The outer two solid lines indicate the limit of the integumental tissue. The extent of embryo development in *M. hupehensis* at a corresponding period is shown in Fig. 35 drawn to the same scale used in figures preceding Fig. 34. Broken lines indicate the extent of endosperm growth which is shrunk away from the nucellus. The middle area is still devoid of such growth.

Often in *M. hupehensis* there were found twin ovules, each with its own ES, both enclosed in a common testa. In some the demarcation between the twins is quite distinct, in others vague. In Fig. 35 only the upper limits of such twin ovules are shown, where the demarcation, shown by a dotted line, could hardly be distinguished. At the left side of the suspensor in this figure there is a bulge which may indicate that at this point another true embryo may be initiated resulting in a "siamese twin." In more mature stages I have observed structurally complex embryos which may have been originated from such a process of development.

The above ends the description of comparative illustrations for *M. arnoldiana* and *M. hupehensis*. The following description is based on *M. hupehensis* material given in Figs. 36–38.

Figure 36 represents an embryo from material fixed two months after shedding of flowers, which is still in a premature stage; while in *M. arnoldiana* the embryos were fully developed and filled the whole

nucellar area. The sac in this particular ovule is divided into two portions indicated by a dotted line. The side which contains the embryo is filled with loose endosperm cells. The other side has only a narrow strip of endosperm shown in the drawing with broken lines. Examining the serial sections, at the upper corner of this portion there was found a very young embryo. As a whole the embryos at this late period of development did not vary much from the one shown in this figure. An enlarged drawing of this embryo is given in Fig. 37. The cells in the suspensor are drawn loosely since their actual limits could not be made out clearly. The round tip represents the beginning of development of the true embryo. A three months old embryo, from a narrow view of cotyledons, is given in Fig. 38 drawn to the same scale as Fig. 34. Between the cotyledons the epicotyle is beginning to be formed. In this drawing the testa which was removed from the seed for better penetration of fixative is not shown. At this period the embryo is ⅓ to ½ way down in the sac and has not yet replaced the endosperm as well as the nucellus.

DISCUSSION

The title of this paper is meant to suggest that embryogeny in *M. hupehensis* occurs by means of development of unfertilized egg cells and further, that embryo sacs in the ovules develop from other cells than megaspores or megaspore mother cells (egg mother cells). The terms *apospory* and *parthenogenesis*, as here applied are meant in the following sense: *Apospory* signifies the development of an embryo sac from a cell other than a megaspore or megaspore mother cell; *Parthenogenesis* signifies the development of an embryo from an egg cell without fertilization. The two processes are included in the term *Apomixis* which signifies the absence of sexual fusion in the reproductive process.

Almost without exception in the ovules of *M. hupehensis* there is one typical meiotic cell that can be recognized by its synezetic chromosomal appearance in early stages. Rarely a meiotic cell is not recognized in this or in an advanced stage. Both in the ovules and in the anthers there is an attempt at reduction in meiotic cells. In the anther the great majority of cells reach the tetrad stage with a wall around each of the resulting cells. The component microspores of the tetrads, however, do not break away and their development ceases at this stage and eventually the tetrads degenerate. Some cells do not even go through reduction but stop at metaphase. A comparable situation exists in the ovules where, if meiotic division is at all successful, one of the resulting megaspores may tend to grow somewhat, while others have ceased to grow or have already disintegrated. However, the author's impression

is that probably never in this species is a megaspore developed into a functional ES. All the evidence available tends to show that the embryo sacs are of aposporic origin.

As was described in the text, in the ovule, in the immediate vicinity of a meiotic cell, there is usually more than one somatic cell with a large nucleolated nucleus which in almost all ovules develops into a typical eight-nucleate embryo sac which sooner or later forms the egg apparatus. A few ovules were found which were devoid of embryo sacs. The ovules themselves continued to grow. In most cases the embryo sacs were complex in appearance and were found to have resulted from the fusion of two or more aposporic embryo sacs. In such embryo sacs more than one egg apparatus is formed, from which the appropriate number of embryos and appropriate number of endosperm layers could be formed. No indication whatever was found of development of embryo sacs and embryos from any other tissue than described in the text. The exact origin of these parts could be fully demonstrated since a very large number of ovules at all significant stages was examined. Furthermore, these stages were carefully checked by using as control a diploid form of apple in parallel observations and there were found no exceptions to the rule indicated above.

Kobel (1931) refers to "diploid parthenogenesis" in an apple variety, "Transparent von Croncels." No reference was found in the literature on apples giving any account of such a phenomenon. Liljefors (1934) has shown apospory to be present in two tetraploid species of *Sorbus*. Rosenberg (1908) describes a similar phenomenon in *Hieracium*. He finds that the greater number of the embryo sacs in the ovules in *Hieracium* are of aposporic origin, and that "Simultaneously with the development of this vegetative cell into an embryo sac, the embryo sac mother cell is, as usual, divided into tetrads with the reduced number of chromosomes, and a normal embryo sac commences to develop. This however, most usually, is sooner or later destroyed by the encroaching aposporic embryo sac. Still in some cases two embryo sacs could be fully developed: one probably typical and the other aposporic. In the same head some ovules have a typical and others an aposporic embryo sac." As in *Hieracium*, in *M. hupehensis* there is a typical meiotic cell present, but apart from that only aposporic cells develop into functional embyro sacs. Rosenberg has made no mention of this point.

To show definitely whether reduced cells play any role in embryo development, a large number of seeds was planted from which a very small number of seedlings was obtained. Of a total of 39 seedlings, two were tetraploids, one had some roots showing the triploid number and

some hexaploid (this plant was destroyed after transplanting; if grown it might have developed into a chimeral plant since such an effect was already noticeable in the seedling), and 36 were triploids, one of which showed a more vigorous growth than others. Tetraploid as well as a few other sister triploid seedlings are now saved for future study. To be positive whether any reductional megaspore actually entered into the formation of a mature ES, the chromosome number in the ES nuclei or anywhere else during embryo development should be studied at the time when some nuclei or cells may be found dividing. Such an examination was not made since in this respect the fixation of my material was not as successful as could be desired. However, based on the observed facts recorded from studying numerous ovules at early and later stages of ES development and the fact that no aneuploid chromosome number could be found in the seedlings examined, we may be justified in concluding that although there is usually a meiotic cell present in the ovules, the embryo sacs, however, develop only from somatic cells in the immediate vicinity of the meiotic cell, at which time meiotic cells degenerate. When the rate of embryo development in *M. arnoldiana* is compared with that of *M. hupehensis*, as was pointed out in the text, the embryo development in the latter was very slow without a single exception. Very few seeds at maturity in *M. hupehensis* were at all fully filled; for the most part they were empty or contained diminutive embryos indicating their somatic origin.

It is a noteworthy phenomenon that in *M. hupehensis*, although an egg cell with a somatic number of chromosomes can develop into an embryo parthenogenetically to insure the stabilization as well as the propagation of the species, this same egg cell is at times receptive to fertilization with a haploid male gamete derived from a diploid species. Considering it in more practical terms, this type of hybridization if successful, may be used as a method of generation of new species artificially, considering that this combination occurred normally with no application of artificial methods. It may be assumed that some of the tetraploid species found in nature have originated in this fashion.

Triploidy in itself is an indication that *M. hupehensis* is a derivative either from a similar species but of diploid form, or from a hybrid between two species and later, through one haploid gamete being fused with a diploid gamete, or from a cross between a tetraploid and diploid species. In any case, the polyploidy in this plant seems to have brought about a genetic unbalance by virtue of which normal sexuality was suppressed but not enough to suppress the inherent property of the ovule to produce a gametophyte, although of sporophytic origin, thus insuring

alternative process of generation fundamental in almost all the plant kingdom. A genetic unbalance due to triploidy seems to have brought about a vegetative tendency of which parthenogenesis is the result, which in itself may be considered as being a vegetative process. In extreme cases the same tendency is expressed in the differentiation of nucellar cells into conductive (xylem) elements (Fig. 15) which are characteristic only of vegetative tissues while nucellar cells serve as a food source for a gametophytic growth.

The same factor seems to be at play in the disintegration of sexual cells in the ovules where these cells begin to degenerate at times even before they have begun to divide. The destruction of these cells in *M. hupehensis* is not a physical process of encroaching of an aposporic ES over a normal one, as Rosenberg reports for *Hieracium,* as if there were a competitive growth between these embryo sacs, but a process likely physiological, since egg mother cells begin to degenerate before an aposporic ES has commenced to develop.

Usually simple hybridization between any two species is not sufficient to lead to parthenogenesis or apomixis, in general, and such a method of propagation seems to be commonly linked with genetic unbalance through polyploidy. The data presented by Gustafsson (1935) in Table 8 seem to substantiate the validity of such an assumption. He presents the data of ten genera all of which in diploid form, with the exception of *Potentilla,* are sexual. Apomixis appears to be prevalent whenever the genom is in odd numbers, 3x, 5x, . . ., 15x the basic number of chromosomes. On the other hand in polyploids with an even number there are both tendencies, apomictic as well as sexual, present.

The prevalence of apomixis in polyploids with odd chromosome numbers may be usually due to a cytogenetic unbalance brought about by random and unequal distribution of chromosomes so that in some species such megaspores may not develop into functional embryo sacs. The triploid apple species studied in this paper differs from ordinary triploids in the fact that sexual cells may degenerate even before a first division is accomplished and not as a result of random and unequal distribution of chromosomes. In this laboratory we analyzed the cytological situation in the Baldwin apple, a triploid form, and found an approximately normal distribution of chromosomes from germinating seeds (see page 106). Here neither the polyploidy nor unequal distribution of chromosomes had any apparent effect on the normal sexual processes.

If specific genes were responsible for the apomictic phenomenon, as Gustafsson seems to argue, then the same phenomenon should have been

equally common in diploid hybrids, which is not the case judging from the table he presents.

The present author's contention is that the parthenogenetic process is fundamentally a vegetative act on the part of the egg cell growing into an embryo without uniting or being stimulated by a sperm. As a whole, in plants, parthenogenesis seems to be linked with polyploidy which accelerates vegetative growth and decreases normal sexual development. Crane and Lawrence (1930) have remarked that in apple "triploids are invariably vigorous." In a hybrid of *Mahonia* × *Berberis*, two closely related genera in Berberidaceae, there is a complete suppression not only of sexuality but even of formation of sexual parts such as flowers. The whole plant is completely vegetative and vigorous in growth. This hybrid has the same number of chromosomes as its parents with 2n = 28 (Dermen 1931). Obviously here polyploidy is not the cause of this peculiarity but it may be due to extreme vigor brought about by combining the two species of closely related genera. We have made attempts to make some artificial hybridization between the above two genera; if successful, the study of the intergeneric plants as well as the full analysis of tetraploid forms derived in *M. hupehensis* mentioned above should throw a good deal of light on the attempts to determine some of the causes of parthenogenesis.

Taxonomically *M. hupehensis* must be considered as a very stable species since very rarely will it fail to breed true from seeds. Most diploid species are more or less cross fertile with other species within the genus and when grown together they will fail to breed true from seeds; hence their propagation must be insured by grafting or by other vegetative methods. *Malus hupehensis* in this respect cannot be considered as a typical species since it differs from the normal in that it may safely be propagated from seeds although grown side by side with other species. As we have pointed out the seeds here develop parthenogenetically and very seldom through fertilization, in which case we may obtain entirely new cytological forms, as was described in the text. It is safe to assume that *M. hupehensis* is of hybrid origin and is consequently an allopolyploid form cytologically, since we assume that mere autopolyploidy through fusion of a haploid and a diploid gamete in a pure species will not bring about a genetic unbalance which would eventually have resulted in parthenogenesis. Some species in Pomoideae that are found to breed true under similar conditions, from seeds, may be suspected of similar phenomena as those described for *M. hupehensis*. This analogy may be extended to other species of similar behavior in other families.

SUMMARY

Malus hupehensis (Pamp.) Rehd. is a triploid species with 3n = 51 chromosomes. Sexuality is completely suppressed through degeneration of sexual cells in both anthers and ovules; however, the propagation of the species is carried on by parthenogenetic method. Evidence of hybrid origin of this species is indicated.

In the ovules embryo sacs are probably entirely formed by apospory in which normal egg apparati are formed. It is the egg cells alone that develop into embryos, and embryos never are formed from any other source. Polyembryony in *M. hupehensis* is found to be linked with the development of complex embryo sacs.

Based on the fact that parthenogenesis is commonly associated with polyploidy, a suggestion is made that the expression of such a phenomenon in *M. hupehensis* may be due to a physiological change brought about by triploidy and that this factor accelerates the vegetative growth in the plant and decreases or entirely suppresses its normal sexual development.

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EXPLANATION OF PLATES 179–181

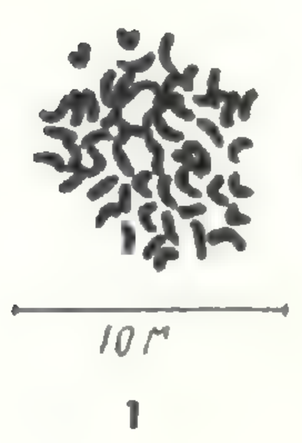
Figs. 1–17 *Malus hupehensis*

Fig. 1. Triploid number 3n = 51 chromosomes from root-tip sections.
Fig. 2. Tetraploid number 4n = 68 chromosomes from root-tip sections.
Fig. 3. II M from anther with 25± chromosomes at each pole. Aceto-carmine preparation. Material prepared between last week of April and first week of May, about ten days before buds turn pink.

Fig. 4. Egg mother cell (EMC) at I M with 51 univalent chromosomes from two sections a and b. Ovaries fixed from buds at pink stage, May 10, 1932.[1]
Fig. 5. EMC at I A in two sections. Pink stage, 5/10/32.
Fig. 6. EMC at pachytene. Pink stage, 5/9/32.
Fig. 7. Two EMCs at late pachytene. Pink stage, 5/10/32.
Fig. 8. EMC at I M. Pink stage, 5/9/32.
Fig. 9. Same as Fig. 8 showing cells in vicinity of the top of the nucellus.
Fig. 10. Outline drawing of an ovule showing the EMC in Fig. 9, the nucellus and the integuments.
Fig. 11. An EMC at I M degeneration. Pink stage, 5/10/32.
Fig. 12. Tetrad stage of megaspores. Upper one failed to divide and degenerated, the large one grown somewhat and its being of a meiotic derivative is indicated by a small nuclear mass outside the large nucleus. Petals falling stage, 5/10/32.
Fig. 13. Two daughter cells from an EMC division, one degenerating and the other at anaphase stage. Some of the chromosomes were off the plates, showing meiotic origin of these cells. Petals just opening stage, 5/10/32.
Fig. 14. A somatic cell with a large nucleolus growing into an ES aposporically, while the meiotic one above is degenerating. Petal just opening stage, 5/10/32.
Fig. 15. Two-nucleate aposporic ES and below it a tetrad of cells (of meiotic origin?) with xylem annular thickenings. Open bloom stage, 5/9/32.

[1]Pink stage buds usually at 5th of May in the Arnold Arboretum.

Fig. 16. Two aposporic embryo sacs, one two-nucleate and the other four-nucleate. Flowers just bloomed stage, 5/10/34.
Fig. 17. A middle section of a compound ES with some 30 nuclei in five serial sections. Flowers just bloomed stage, 5/10/34.
Fig. 18. *M. arnoldiana.* A complete ES with egg apparatus (egg cell and synergids), two polar nuclei and three antipodal cells, before fertilization. Before shedding of petals, 5/11/34.
Fig. 19. *M. hupehensis.* A complete ES as in Fig. 18. One polar nucleolus and one synergid cell, dotted, from an adjacent section superimposed in a single drawing. Before shedding of petals, 5/10/34.
Fig. 20. *M. arnoldiana.* An unfertilized ES. Antipodals have disappeared. Just about at shedding of calyx, 5/19/34.
Fig. 21. *M. arnoldiana.* A fertilized ES. Otherwise same as in Fig. 20.
Fig. 22. *M. hupehensis.* Endosperm development and tubular growth of ES. At shedding of calyx, 5/18/34.
Fig. 23. *M. hupehensis.* Twin ES. Parts drawn at the side from an adjacent section. Antipodals have disappeared. From same material as Fig. 22.
Fig. 24. *M. hupehensis.* A single ES. One of the cells of the egg apparatus drawn from an adjacent section. From same material as Fig. 22.
Fig. 25. *M. arnoldiana.* Proembryo stage with scant endosperm. Material fixed 5/31/34.
Fig. 26. *M. arnoldiana.* Longitudinal section of a whole young seed at the time of proembryo about 12 cells long. This shows the extent of tubular growth of ES. Material same as in Fig. 25.



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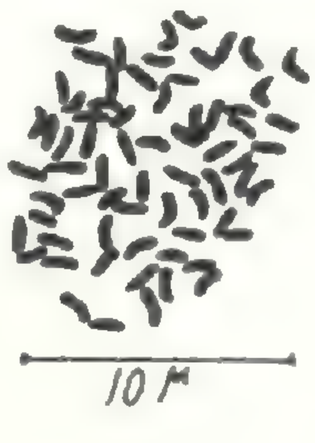

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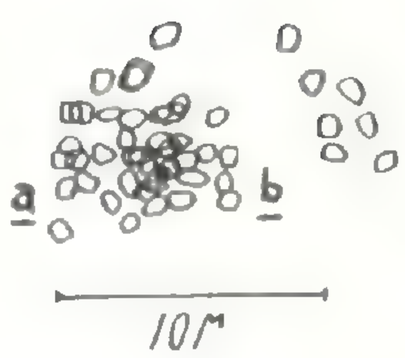

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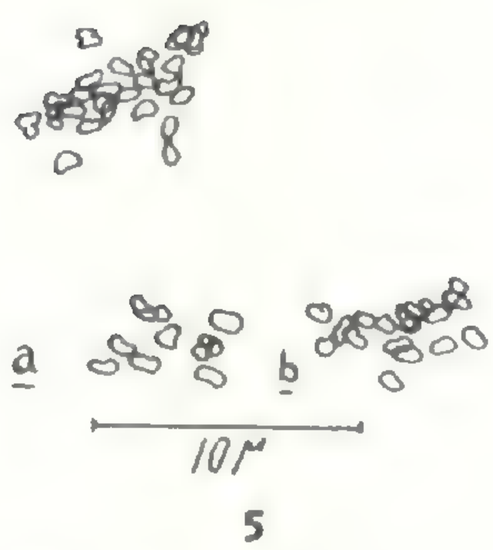

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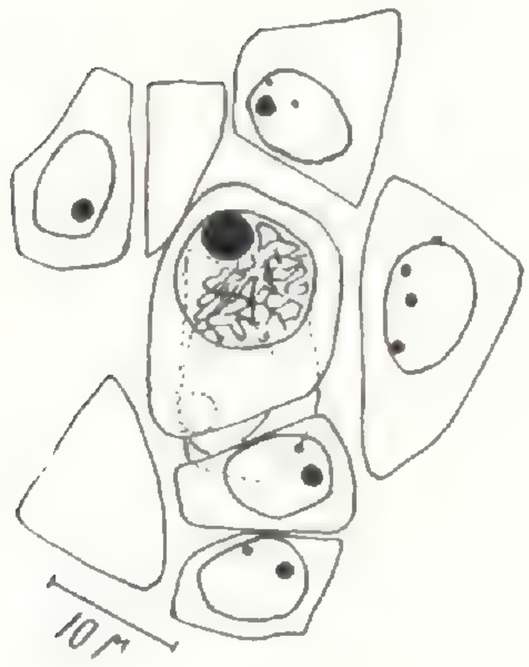

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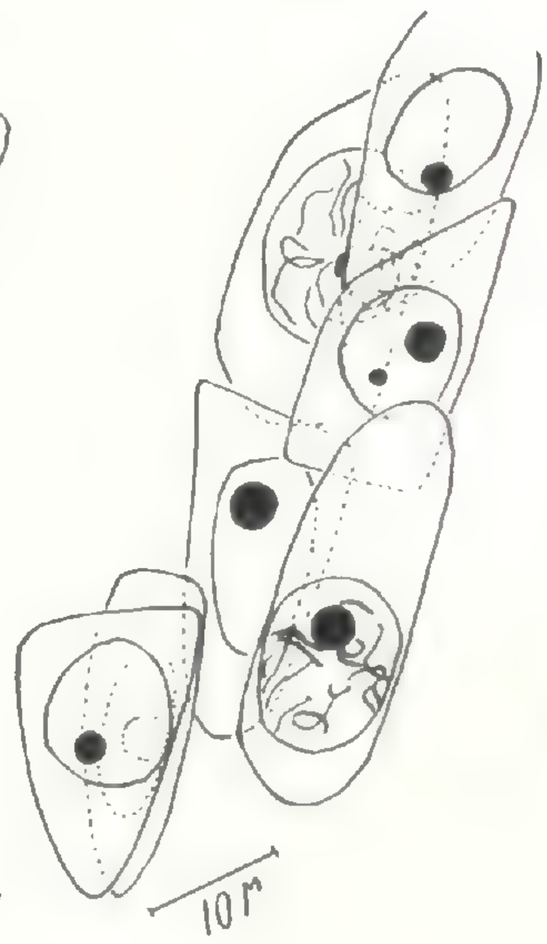

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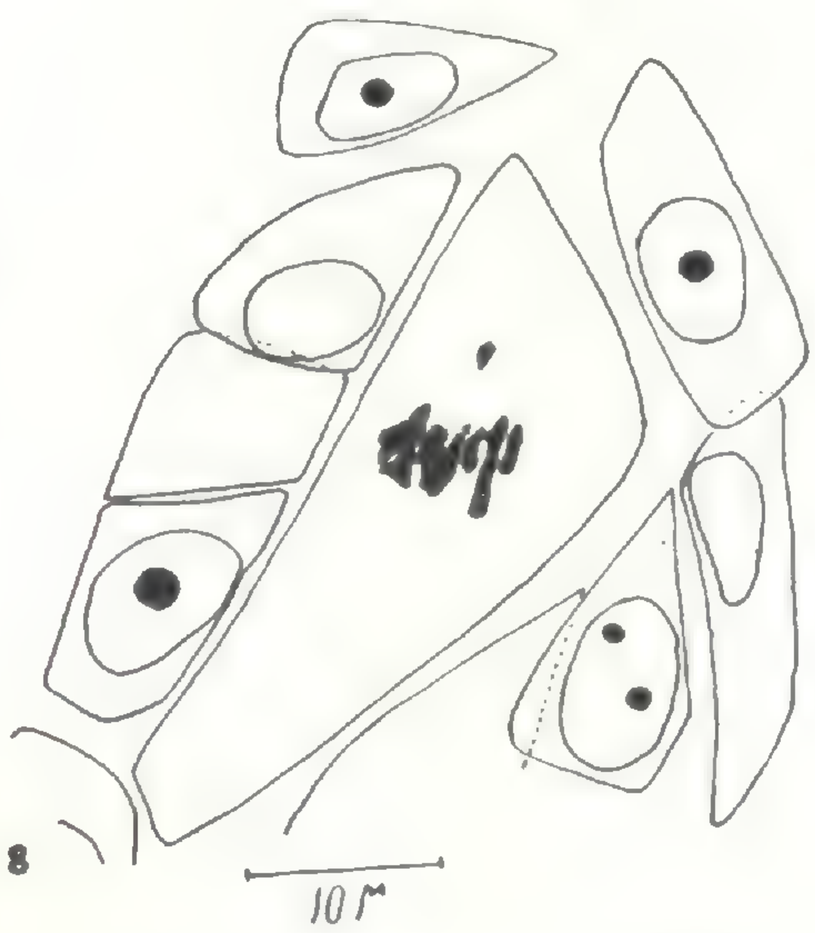

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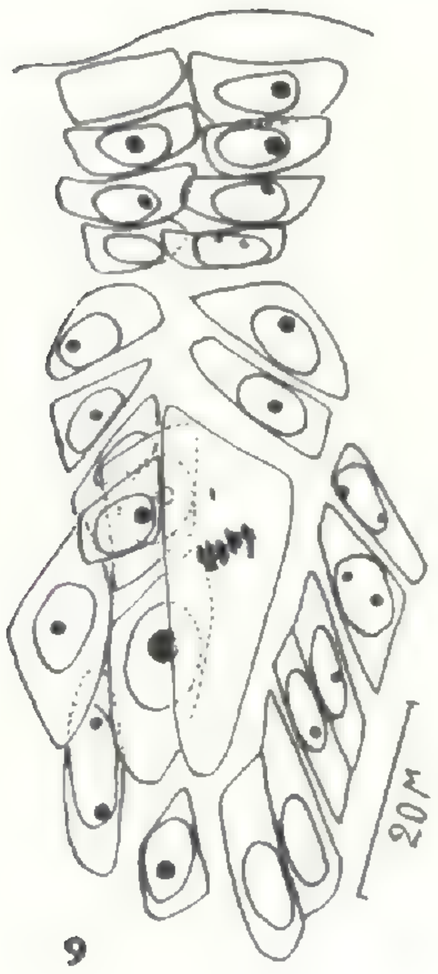

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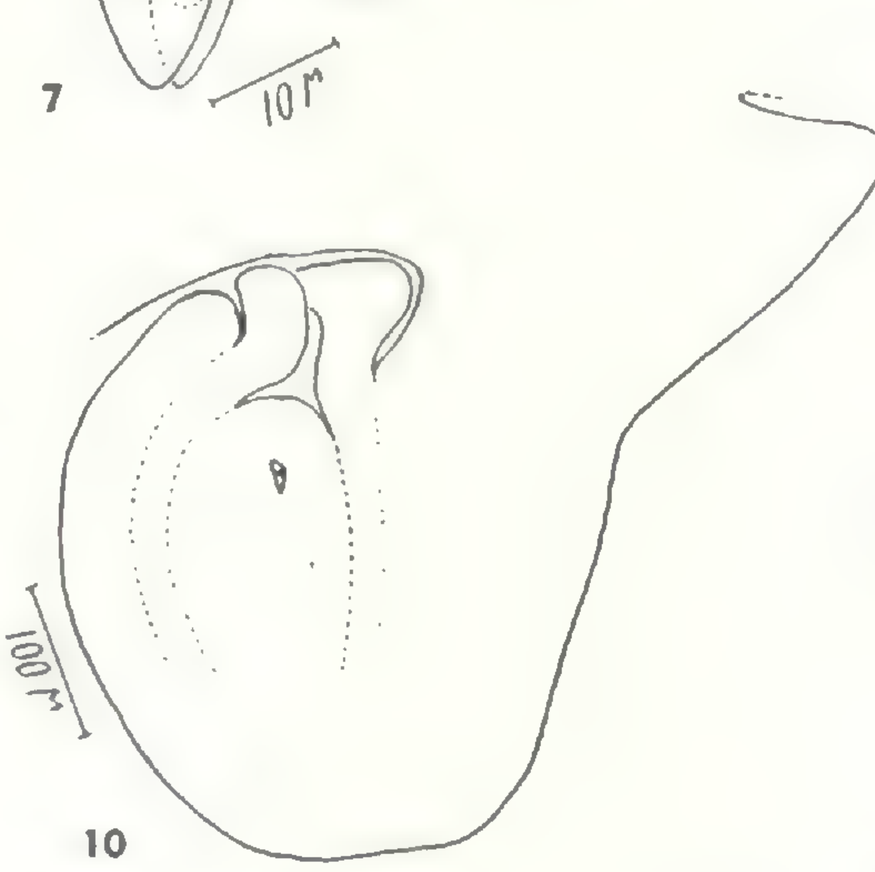

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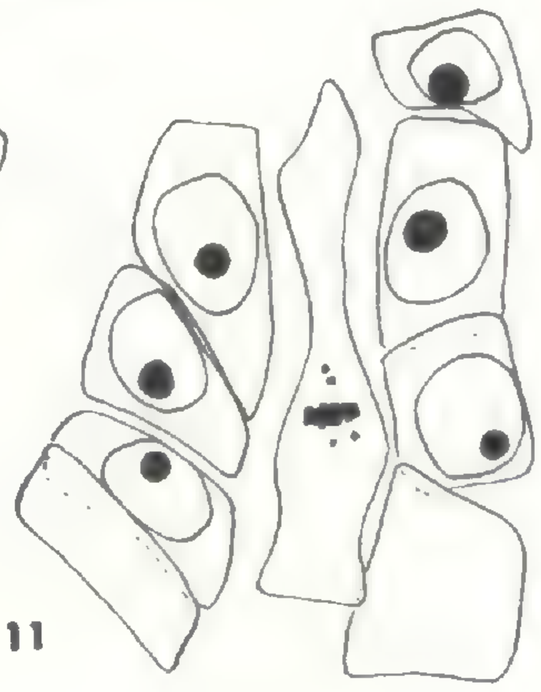

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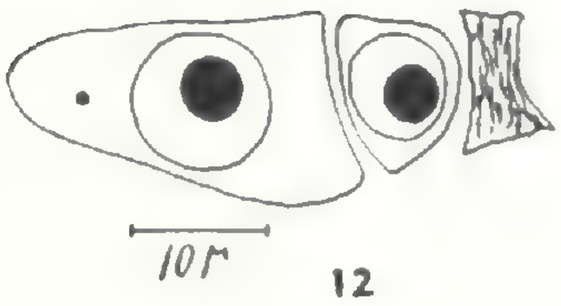

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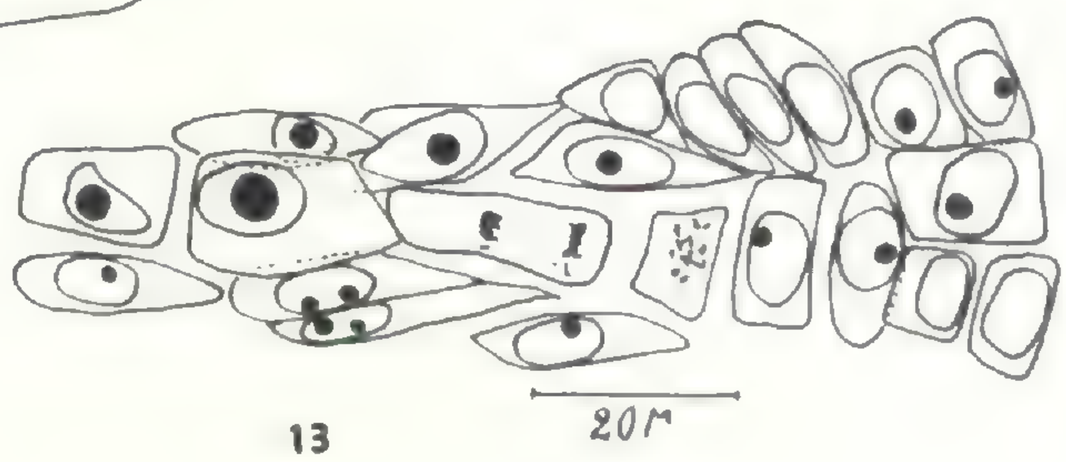

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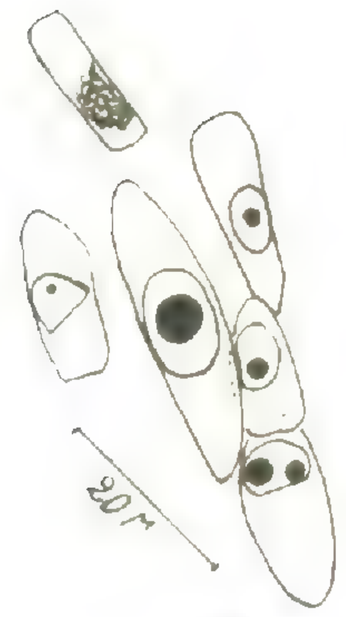
APOSPORIC PARTHENOGENESIS IN MALUS HUPEHENSIS



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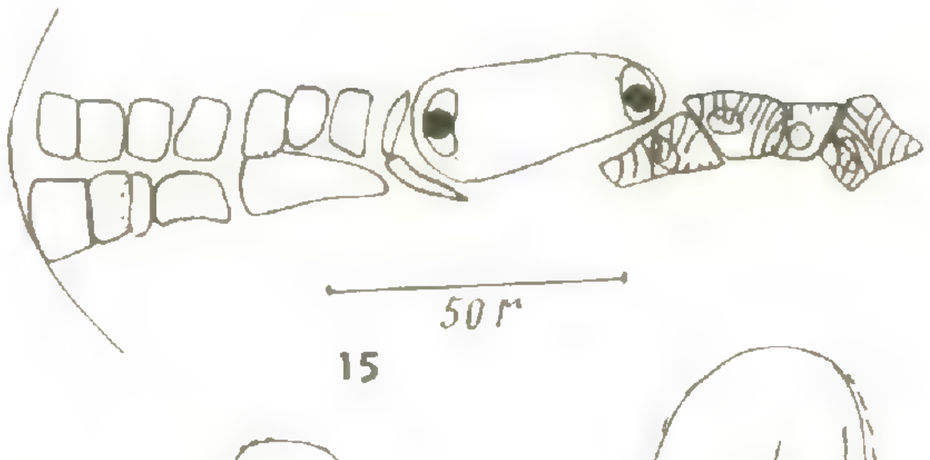

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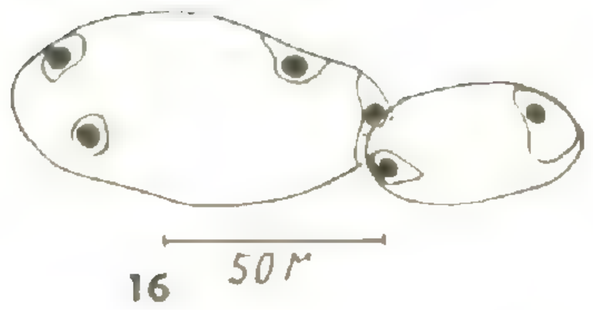

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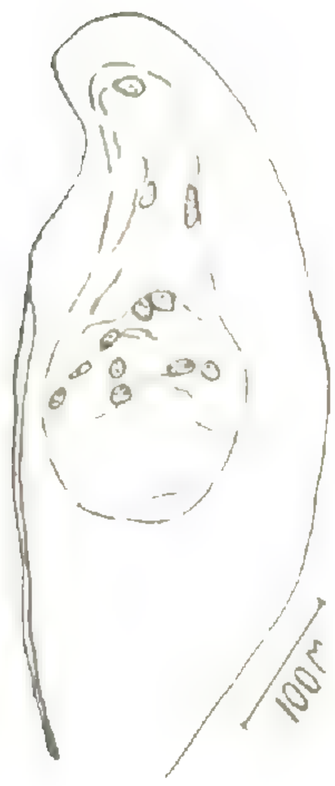

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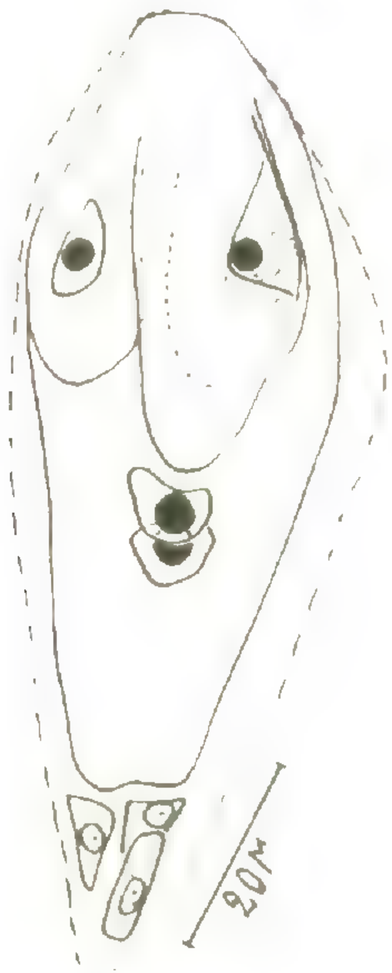

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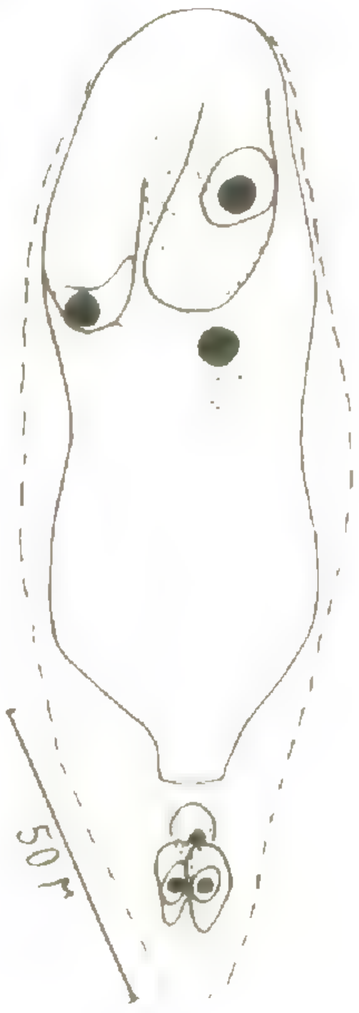

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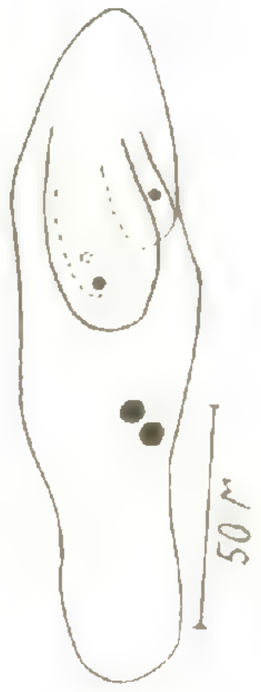

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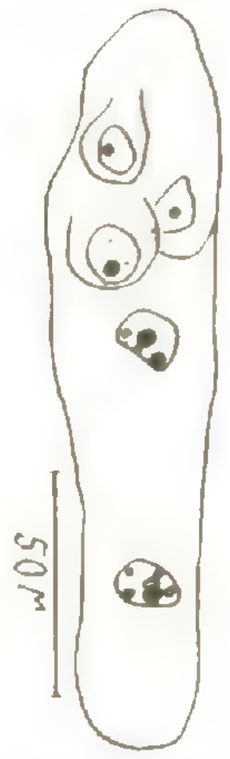

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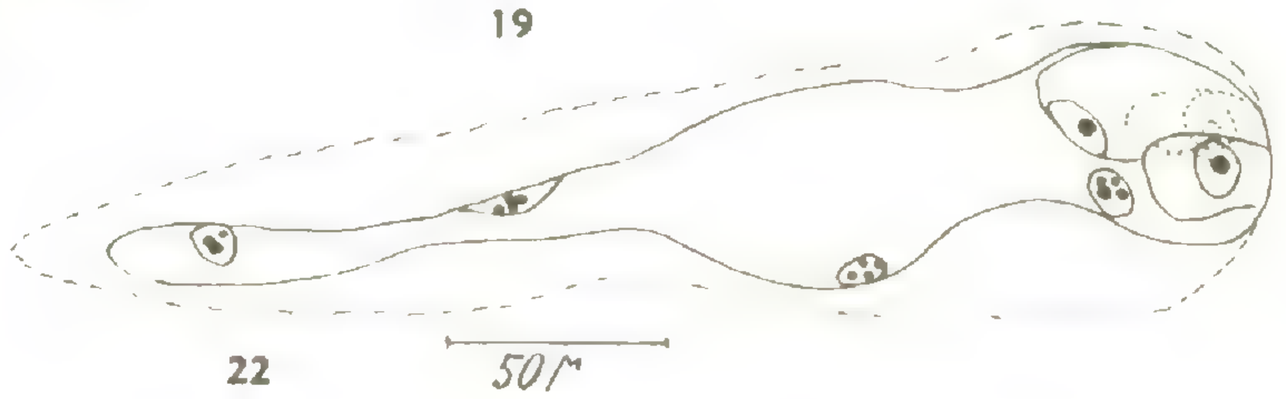

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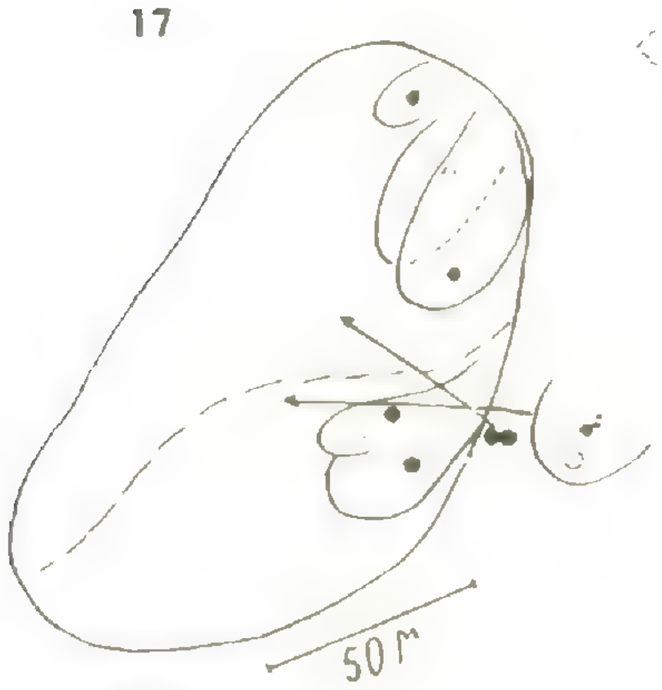

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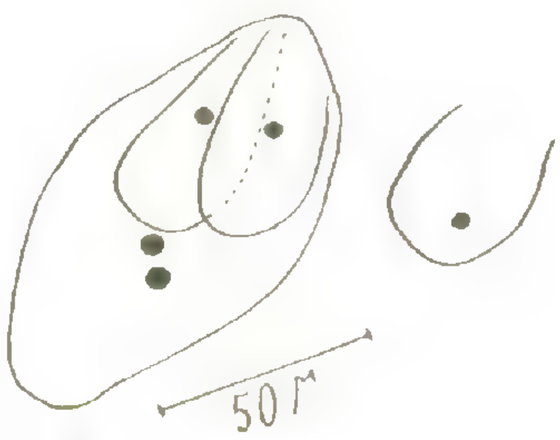

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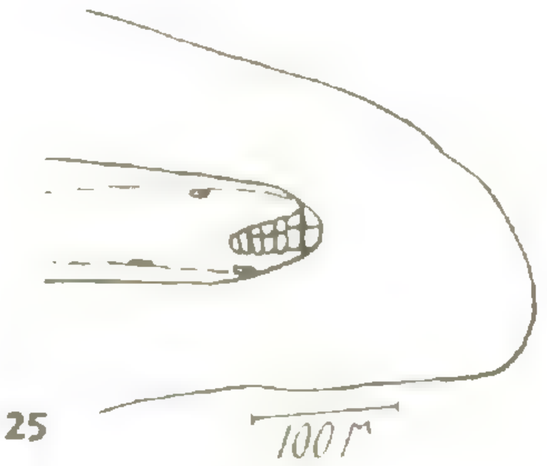

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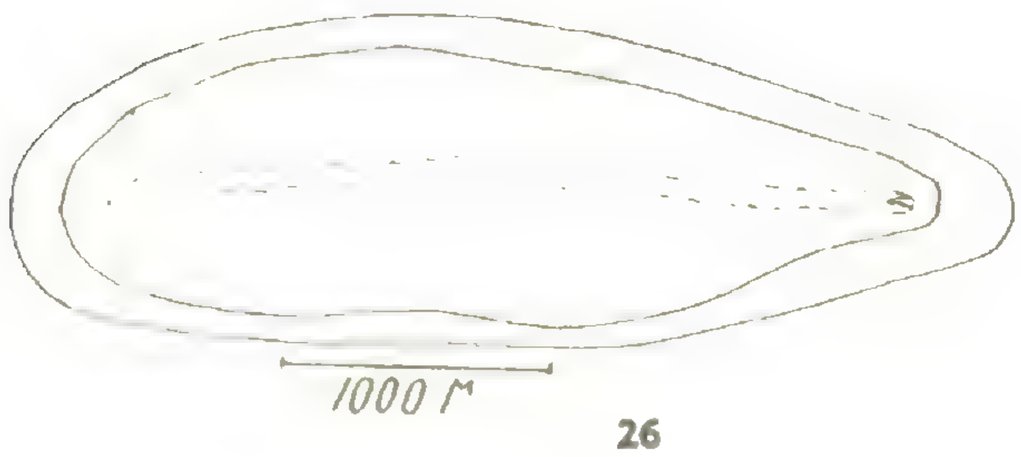

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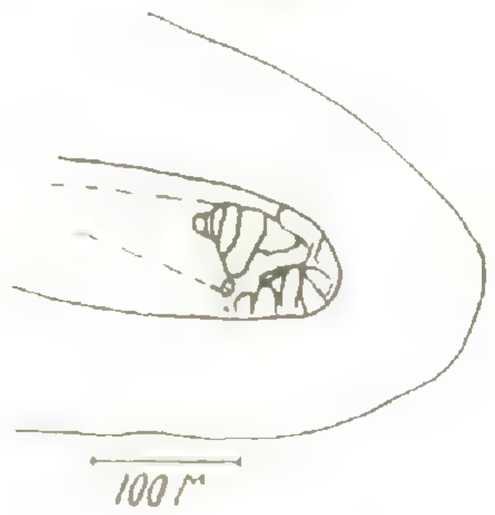

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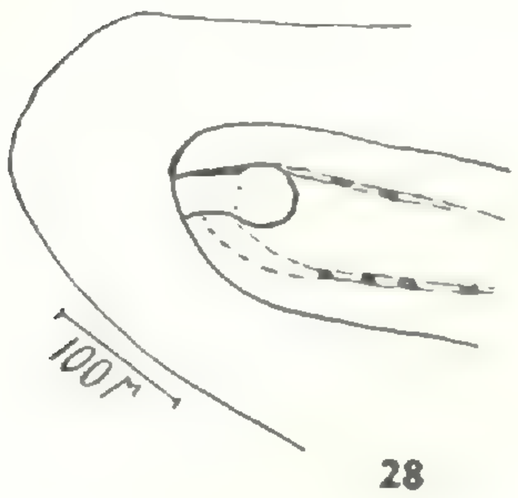
APOSPORIC PARTHENOGENESIS IN MALUS HUPEHENSIS



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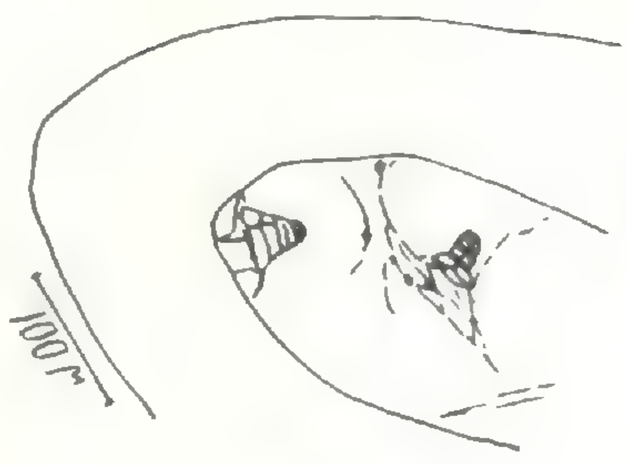

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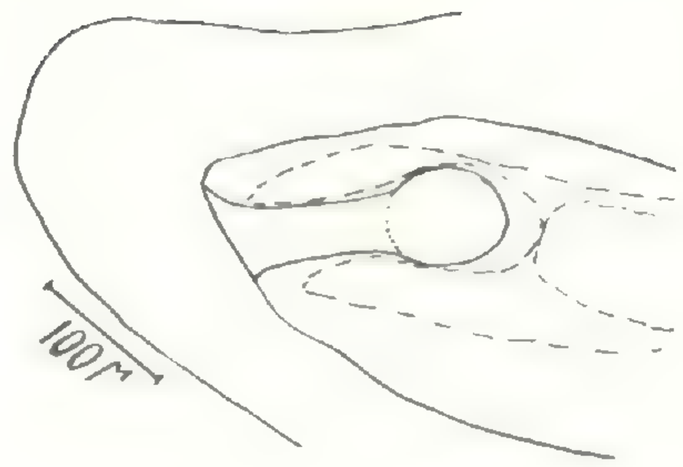

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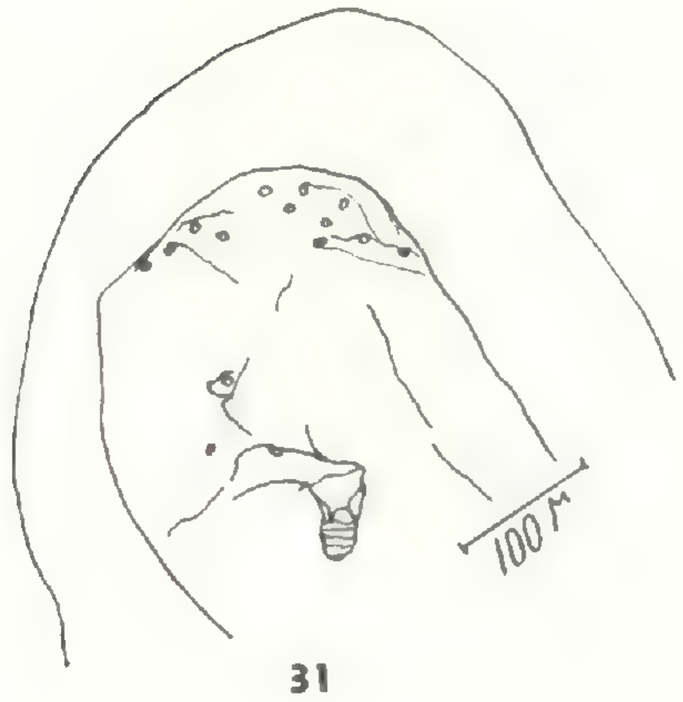

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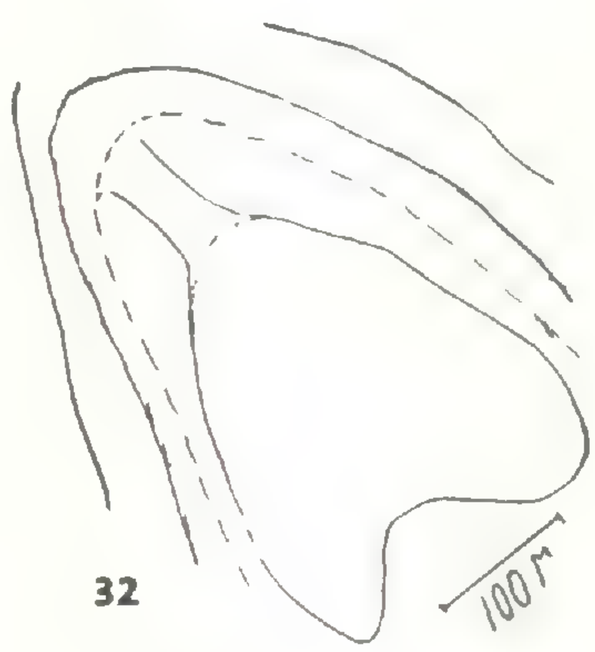

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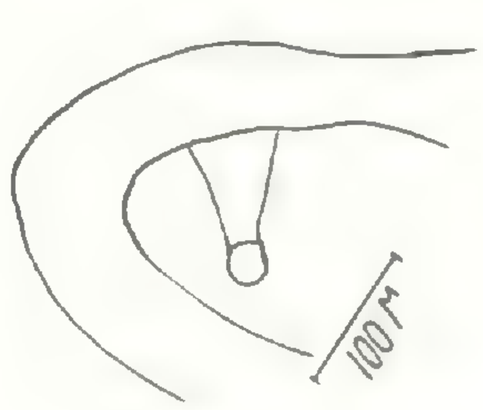

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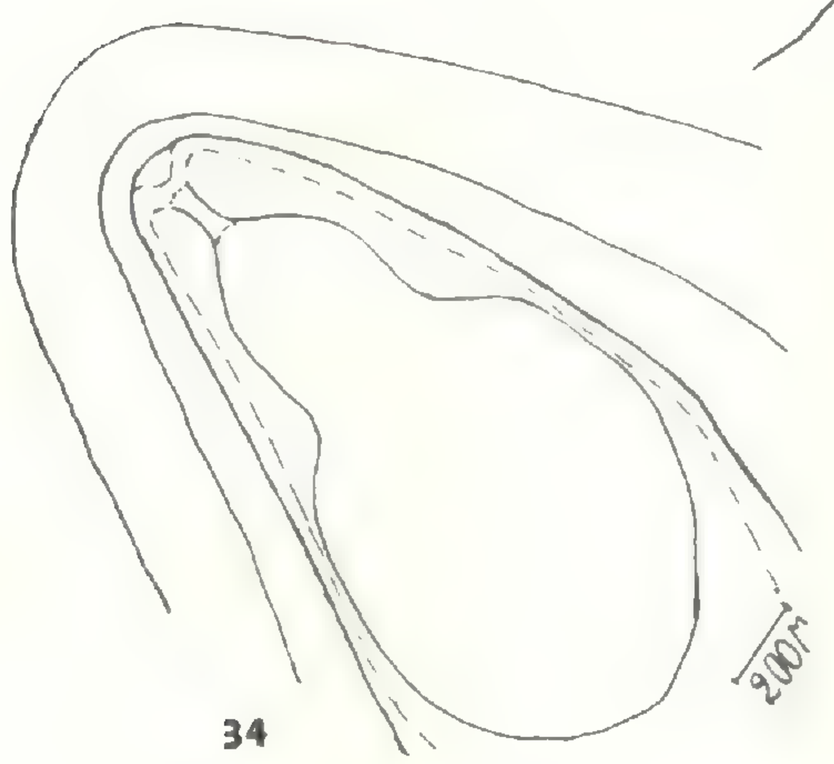

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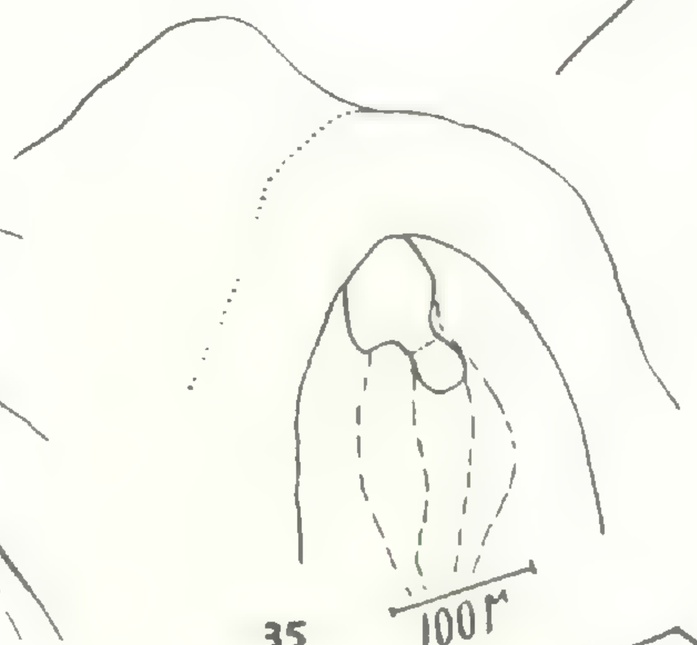

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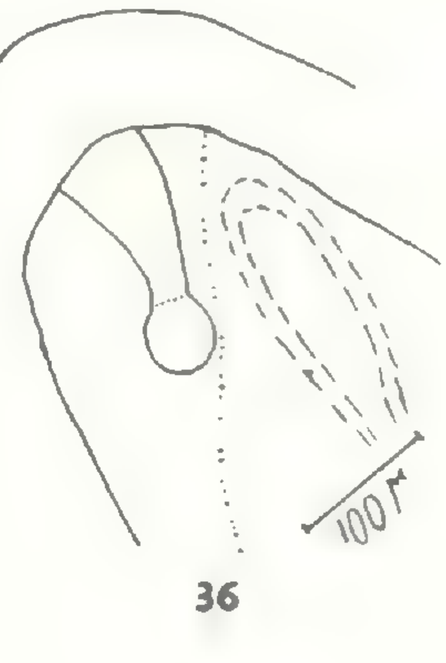

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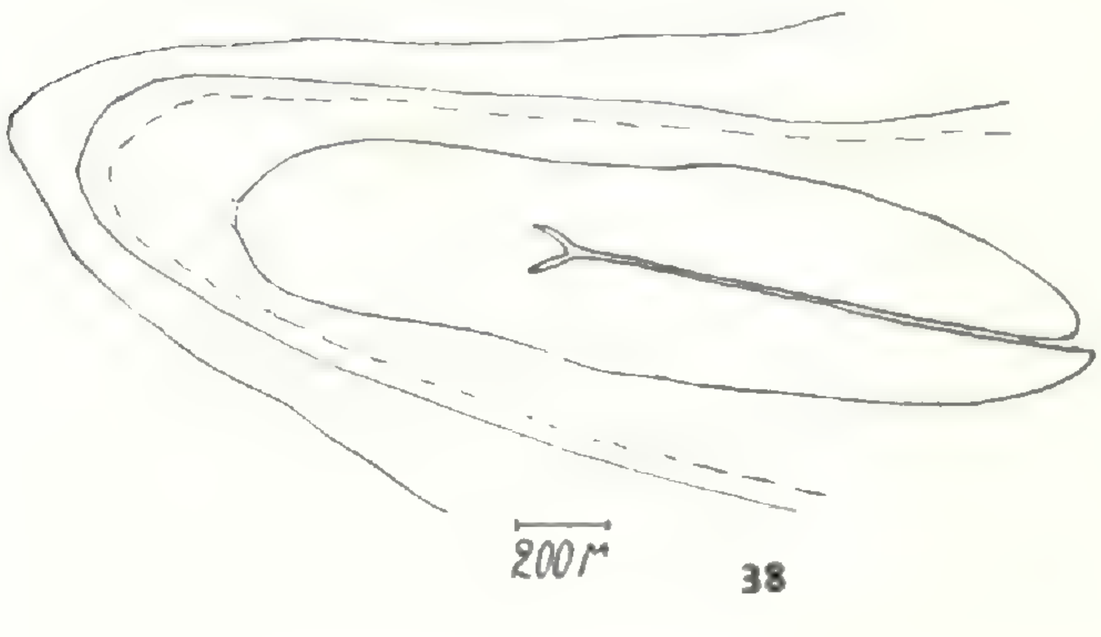

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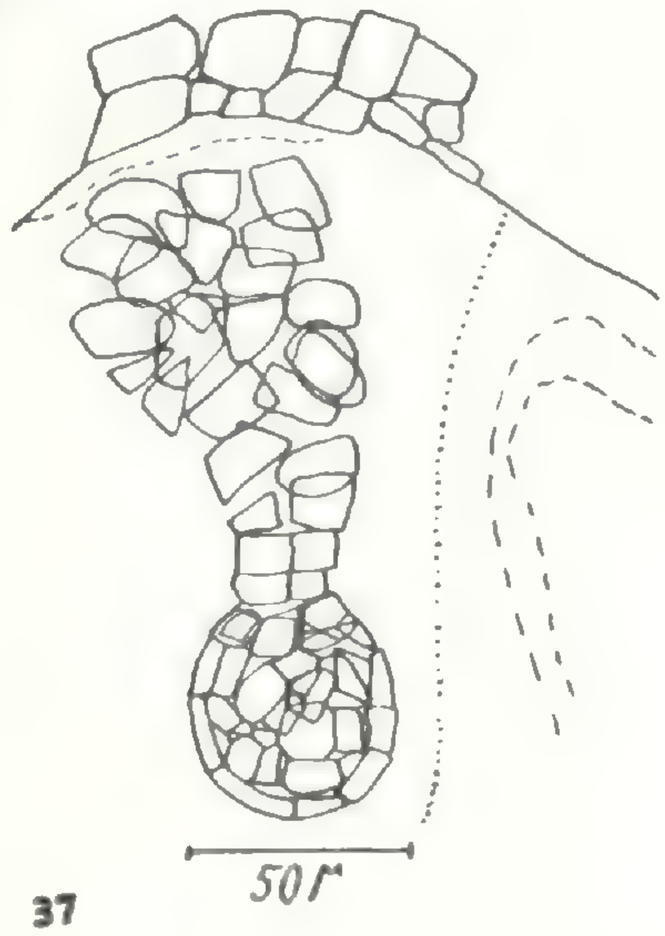

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Fig. 27. *M. hupehensis.* Proembryo and beginning of endosperm development. Material fixed 5/31/34.
Fig. 28. *M. arnoldiana.* Suspensor and true embryo. Material fixed 6/5/34.
Fig. 29. *M. hupehensis.* Two proembryos in one complex ES. Lower one is away from nucellus. Material fixed 6/5/34.
Fig. 30. *M. arnoldiana.* Suspensor and embryo at a later stage with considerable amount of endosperm. Material fixed 6/11/34.
Fig. 31. *M. hupehensis.* Still in proembryonic stage. This also chosen to show the development of embryo away from nucellus. Material fixed 6/11/34.
Fig. 32. *M. arnoldiana.* Older embryo with suspensor. Material fixed 6/18/34.
Fig. 33. *M. hupehensis.* Just the beginning of proembryo differentiation into suspensor and true embryo. Endosperm still scarce. Material fixed 6/18/34.
Fig. 34. *M. arnoldiana.* Advanced stage of embryo. The nucellus is not yet completely replaced by endosperm. The outer two solid lines indicate the limits of testa. Material fixed 6/26/34.
Fig. 35. *M. hupehensis.* Twin ovule marked with a dotted line. In the one at the right is shown the somewhat advanced stage in suspensor and embryo differentiation compared with the one in Fig. 33. Broken lines indicate the extent of endosperm development. Material fixed 6/26/34.
Fig. 36. *M. hupehensis.* Twin ES, one with advanced stage of suspensor and embryo. This sac is completely filled with loose endosperm tissue. The other has in another section a proembryo just beginning to differentiate into suspensor and true embryo. This latter sac has a little growth of endosperm. Material fixed 7/14/34.
Fig. 37. *M. hupehensis.* Enlarged drawing of the embryo in Fig. 36 to show the development of embryo independent of nucellus.
Fig. 38. *M. hupehensis.* The stage of embryo development three months after meiotic stage. The embryo is not yet halfway down in the nucellus. The testa is not shown in this figure. Material fixed 8/7/34.

CYTOLOGICAL LABORATORY, ARNOLD ARBORETUM,
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FERTILIZATION IN THE BALDWIN APPLE, A TRIPLOID VARIETY

HAIG DERMEN

THE DATA presented in Table I were obtained by studying sectioned root-tips from germinating seeds of the Baldwin apple. Several hundred seeds were placed in a box mixed with well moistened peat and frozen in a refrigerator for more than two months, from 1/9/34 to 3/19/34. They were then planted in soil in a flat. The seeds began to germinate during the latter part of March and one primary root-tip from each individual seed was cut and fixed in Lewitzky's solution. Four separate collections were made, 3/30/34, 4/2/34, 4/3/34 and 4/18/34. Fourteen seeds were analyzed from the collection of 3/30/34, 41 from that of 4/2/34, 45 from that of 4/3/34 and 36 from that of 4/18/34. Each root-tip was numbered and each group was recorded separately. Studying each group separately, no appreciable difference in the distribution of chromosome numbers was found, indicating that there was no segregation of chromosome numbers due to difference in seeds germinating at different times. Moffett (1931) has analyzed the somatic chromosome numbers of 32 seedlings obtained from four different $3n \times 2n$ crosses and has found 10 seedlings having 41 chromosomes, other seedlings sharply varying from this number. Based on this observation he remarks that "41 chromosome number is the secondary diploid number (thirty-four). It is to be imputed that the high frequency of seedlings with 41 chromosomes is due to the greater viability of the $17 + 7$ gametes in the triploid rather than to their zygotic viability, since seedlings having other chromosome numbers are frequently more vigorous than the 41 type."

Moffett has observed secondary pairing in the meiotic metaphase chromosomes of all the diploid types of the Pomoideae, forming sexivalent and quadrivalent groups and in extreme cases seven groups — three sexivalents and four quadrivalents. Because of this and the fact that he found more seedlings with 41 chromosomes than with other numbers, he has concluded that the 34 chromosomes of the diploid Pomoideae are of seven types, of which four are presented four times and three are presented six times, and that the haploid number 17 is a secondary basic number of 7, the ancestral basic number. A critique of this point of view is presented by Sax (1933).

At Dr. Karl Sax's suggestion the present writer examined the somatic number of chromosomes from 136 germinating seeds. Of these seeds 130 showed numbers ranging from 35 to 51 (Table I) and six seeds had the following numbers: 1 = 53, 1 = 57, 1 = 58, 1 = 59, 1 = 62, and 1 = 65 chromosomes (these are not included in the table). Here we notice that the class with 40 chromosomes is higher than the class with 41 chromosomes. The distribution here recorded is quite random and does not suggest that a gamete with 17 + 7 chromosomal combination has any advantage over the other combinations. Therefore, the fact that the class 41 singly is not larger than other classes, but conforms quite nearly to the expectation on the basis of normal distribution, invalidates Moffett's theory that a 17 + 7 chromosomal combination is more viable than others. The only peculiarity observed in this table is that the class with 39 chromosomes has only 9 seeds, fewer than expected, in which case perhaps for some reason some eggs with 22 chromosomes were either too few or failed to be fertilized.

TABLE I

CHROMOSOME DISTRIBUTION IN BALDWIN APPLE SEEDS

Chromosome number in seeds	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51
Number of seeds	-	1	3	2	16	9	24	20	16	13	10	6	4	1	2	-	-	3

Statistical data: Mean = 41.36 ± 0.173; σ = 2.93 ± 0.122; C.V. = 7.09 ± 0.296.

Pollen germination in the Baldwin apple is about 11–12% (Crane and Lawrence, 1930). By making breeding tests Sax (1922) has shown that the Baldwin is self sterile in Maine. The data presented here are from seeds of fruit set by open pollination. If the seeds had resulted from self pollination or cross pollination with another triploid form, the class center should have been around 51 and not, as in the table, far below this and with only five seeds above it. This strongly indicates that the Baldwin apple is self sterile in Massachusetts as well as in Maine and that it is easily cross fertile with diploid varieties. In this case, over 95% of the seeds must have resulted from pollination with haploid gametes from diploid varieties. The six seeds probably were the result of fertilization of eggs that contained more than 34 chromosomes which may have been due to restricted reduction division when at the first metaphase chromosomes fail to reduce and the great majority

of chromosomes go into resting stage again, while a few form small microcytes. Such cases were observed in *Rhoeo discolor* when treated with cold or heat. The fact that there were only three seeds with 51 chromosomes and none immediately below makes remote the probability of the six seeds with higher numbers having resulted from pollination with another triploid variety. On the basis of 3n × 3n cross with the union of gametes with 25 ± chromosomes, seeds with chromosomes ranging around 51 as a central point should have been numerous which obviously is not the case.

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TWO SPRUCE-INFECTING RUSTS CHRYSOMYXA PIPERIANA AND CHRYSOMYXA CHIOGENIS

J. H. Faull

Chrysomyxa Piperiana (Arthur) Sacc. & Trott. is a common rust on the Pacific slope of the northwestern United States, and within that region has been collected in Washington, Oregon and northern California. Up to the present it has been recognized on *Rhododendron macrophyllum* Don (*Rh. californicum* Hook.) only, and on that host in its uredial stage only. The earlier collections were usually labelled *Chrysomyxa Rhododendri* DeBary, but evenually Arthur diagnosed it as a new species and described it from its uredia under the name *Melampsoropsis Piperiana*. Recent successful infection experiments, however, conducted in the greenhouses of the Arnold Arboretum, demonstrate that *Peridermium Parksianum* Faull on *Picea sitchensis* (Bong.) Carr. is the haploid phase of this rust. Moreover, abundant telia, teliospores and basidiospores have been discovered in material collected in Oregon by Dr. G. D. Darker. So it is now possible to present a complete taxonomic description of *Chrysomyxa Piperiana*.

The cultures referred to were made by sowing the aeciospores of *Peridermium Parksianum* on two small potted plants of *Rhododendron macrophyllum;* two similar ones served as controls. All four were grown from seed of British Columbia origin, sown February 8, 1928 by Mr. William H. Judd at the Arnold Arboretum. The greenhouses were entirely free from Rhododendron rust of any kind.

The aecial material used as inoculum was collected by Mr. H. E. Parks at Trinidad, Humboldt County, California, November 23, 1933 and sent in fresh condition by air mail. The aeciospores were sown five days later. A relatively small percentage of the spores germinated, but with the liberal amount employed the number was amply sufficient. Within a month to six weeks many small yellow lesions developed on the inoculated plants. Thereafter until early April the lesions, some of them slightly swollen, seemed to remain in a somewhat stromatic resting condition. Then hypophyllous uredia, usually about one to a lesion, began to form on several of the lesions. The first discharge of urediospores was noted April 27, 1934. Careful studies of both uredia and urediospores were promptly made. Fortunately, herbarium material (a single rusted leaf) was harvested prior to serious fumigation injury

in June. The control plants remained throughout without any sign of infection.

The discharged urediospores were yellow, ellipsoidal or linear, often attenuate at one or both ends, straight or slightly curved. Their walls were hyaline, closely tuberculate and 1.5–3.0 μ thick. Forty spores from the same sorus measured 16.0–27.4 × 27.4–68.5 μ and averaged 22 × 46 μ. Razor sections of the uredia showed that the spores were borne catenulately and separated by intercalary cells. They also revealed the presence of a well-marked peridium. The peridium consists of a single layer of laterally adherent cells, the terminal cells of the urediosporogenic, primordial columns. The finding of a peridium clashes with current descriptions of the uredium of *C. Piperiana*. But sections of type material or other field-collected specimens show exactly the same kind of peridium as found in my cultures. Indeed, the rust as obtained in cultures answers in all respects to *C. Piperiana*.

With regard to the telia, lack of acquaintance with them is probably due to the fact that they are of brief duration, their occurrence coinciding with a short period of susceptibility to infection of young spruce needles; and so they have been missed by collectors. They surely cannot be rare. Once familiar with their appearance, remains of them can be detected in many existing collections. It is likewise probable that this rust is not infrequent on spruces within its range. Recognition is easy because of the striking microscopic characters of both spermogonia and aeciospores.

Chrysomyxa Piperiana (Arthur) Sacc. & Trott. in Syll. Fung. **21**: 716 (1912). (II.) O, I, II and III.

Melampsoropsis Piperiana Arthur in North Am. Flora, **7**: 120 (1907). II.

Caeoma Piperianum (Arthur) Sacc. & Trott. in Syll. Fung. **21**: 787 (1912). II.

Peridermium Parksianum Faull in Jour. Arnold Arb. **15**: 86 (1934). O, I.

O. Spermogonia on needles of current season, hypophyllous, numerous, biseriate, conspicuous, yellowish, then reddish-brown, slightly elevated, aparaphysate, immersed, subtriangular in vertical section, subepidermal, 228–315 μ broad and 125–155 μ deep, averaging 260 × 140 μ; spermatiophores unbranched; spermatia globose to broadly ellipsoidal, 2.7–3.2 × 3.0–5.0 μ.

I. Aecia (peridermia) on needles of current season, yellow, hypophyllous, irregularly biseriate, on yellowish discolored portions of affected needles, circular or somewhat laterally compressed in transverse section, cylindrical, 0.4–1.2 mm. in diameter and 1.0–2.2 mm. high;

peridium colorless, rupturing at the apex; peridial cells polygonal, elongate vertically, subimbricate, in a single layer, 18–26 × 48–88 μ, with outer walls smooth, 0.7–1.0 μ thick, and inner walls finely verrucose, about 1.5 μ thick; aeciospores yellow, fusiform or narrowly ellipsoidal, straight or curved, rarely subglobose, 13–24 × 25–111 μ, usually fusiform and averaging about 16 × 70 μ; walls of aeciospores densely and finely warted, hyaline and about 1 μ thick.

II. Uredia hypophyllous, pustular, waxy before rupture, subepidermal, 0.2–0.4 mm. in diameter, on solitary or aggregate areolae that constitute the pale green to yellowish brown lesions, one each to an areola; peridium distinct, 10–14 μ thick; peridial cells in a single layer, angular, thin-walled, 13–19 μ in diameter; urediospores yellow, catenulate, with intercalary cells, pulverulent as discharged, or extruded in a cylindrical column (resembling the telial column of a *Cronartium*) from the apically ruptured uredium, ellipsoidal to linear, often narrowed towards each end, straight or slightly curved, 14–27 × 27–100 μ, averaging 16–21 × 41–67 μ; walls of spores hyaline, 1.5–3.0 μ thick, coarsely and closely verrucose.

III. Telia on overwintered leaves, hypophyllous, yellow, pulvinate, waxy, rupturing widely at maturity and eventually becoming concave, subepidermal, one or two to an areola on solitary or aggregate areolae that constitute the pale green to yellowish brown lesions, subcircular, 0.2–0.5 mm. in diameter; no peridium; teliospores yellow, catenulate, 3 to 6 or more spores in a chain, without intercalary cells, smooth, thin-walled, 11–16 × 13–22 μ. The teliospores germinate in situ at maturity and in centripetal order. Basidia slightly curved to strongly arched, 4-celled, 7–8 μ thick and up to 40 μ long. Basidiospores subglobose, 8–11 μ in diameter.

The foregoing description of telia is based on two collections of overwintered leaves — (a) Still Creek, Clackamas Co., Ore., elev. 3500 ft., July 7, 1929, *G. D. Darker* (2682), Arnold Arb. Path. Herb. no. 179; (b) Rhododendron, Clackamas Co., Ore., elev. 2000 ft., July 9, 1929, *G. D. Darker* (2697), Arnold Arb. Path. Herb. no. 194.

The sequence of spore production on overwintered Rhododendron leaves seems to be — uredia in spring, telia during period of susceptibility to infection of new spruce needles, then a copious crop of uredia.

Chrysomyxa Chiogenis Dietel is a rust long known on *Chiogenes hispidula* (L.) Torrey & Gray, both as to its uredia and telia. Though it has been reported from Wisconsin, Newfoundland and northern New York only, it is much more widely distributed. Thus, herbaria in Harvard University contain, in addition, collections from Ontario, Quebec,

TABLE 1

Chrysomyxa Chiogenis from *Chiogenes hispidula* to *Picea glauca* (Moench) Voss.

Date of inoculation	First appearance of lesions	First appearance of peridermia	Date harvested	No. of needles infected	No. of needles with peridermia
23.vi.24	15 days	29 days	5.viii.24	53	47
24.vi.24	16 "	35 "	5.viii.24	20	19
24.vi.24	——	30 "	5.viii.24	1	1
17.vi.25	——	35 "	5.viii.25	—	5
17.vi.25	——	35 "	5.viii.25	—	25
17.vi.25	——	33 "	1.viii.25	—	38
16.vi.28	12 days	——	31.vii. 28	14	7
16.vi.28	12 "	——	31.vii. 28	92	42

TABLE 2

Chrysomyxa Chiogenis from *Chiogenes hispidula* to *Picea mariana* (Mill.) B.S.P.

Date of inoculation	First appearance of lesions	First appearance of peridermia	Date harvested	No. of needles infected	No. of needles with peridermia
25.vi.24	——	——	10.ix. 24	2	2
17.vi.25	——	35 days	5.viii.25	20	12
17.vi.25	——	35 "	17.viii.25	10	4

TABLE 3

Chrysomyxa Chiogenis from *Picea glauca* to *Chiogenes hispidula*

	Experiment 1	*Experiment 2*
Source of inoculum	Experiment 1 of Table 1	Experiments 4 and 5 of Table 1
Date of inoculation	August 8, 1924	August 5, 1925
First indication of lesions	September, 1924	September, 1925
First appearance of sori	Late May, 1925	About June 1, 1926
Date harvested	June 5, 1925	June 20, 1926
No. of inoculated branches	2	5
Leaves on inoculated branches	113	120
Leaves infected and with sori	19	65
Kinds of sori	Uredia and young telia (?)	Uredia and telia

New Brunswick and New Hampshire. Doubtless its range is much greater still. In some localities it is common; but even in such places, because of its inconspicuousness, it easily escapes detection unless the prostrate branches of its host are turned over for inspection.

So far no host other than the creeping snowberry has been recognized for this rust, but successful infection experiments summarized below demonstrate that at least two species of *Picea* can serve as hosts for the haploid phase. These experiments were conducted at the field laboratory of forest pathology on Bear Island in the Timagami Forest Reserve, Ontario; and in connection with them I gratefully acknowledge the assistance afforded by Mr. W. R. Watson, Professor E. H. Moss and Dr. G. D. Darker.

The numbers of uredia on the infected leaves of experiment 1 were, respectively — 18, 16, 35, 24, 17, 45, 20, 26, 51, 38, 34, 75, 40, 56, 36, 24, 32, 28, 19. Experiment 1 was conducted on a potted plant at the laboratory; Experiment 2, on an undisturbed plant in a carefully selected spot in the field in which no rust could be found and which was well protected from chance infection. Uninoculated branches of the experimental plants served as controls, and in addition surrounding plants in experiment 2. All controls remained free from rust except that in experiment 1 seven uredia were found on a 4-leaved twig on a branch immediately below the inoculated branches.

Chrysomyxa Chiogenis Dietel in Bot. Gaz. **19:** 303 (1894). (II.) I, II and III.

Melampsoropsis Chiogenis (Dietel) Arthur in Rés. Sci. Congr. Bot. Vienne, p. 338 (1906). II.

O. Spermogonia unknown; apparently lacking.

I. Aecia (peridermia) on needles of current season, yellow, hypophyllous, biseriate, on yellowish discolored portions of affected needles, lenticular to subcircular in transverse section, 0.5–1.2 mm. long and 0.5–1.5 mm. high; peridium colorless, rupturing at the apex: peridial cells polygonal, elongate vertically, not imbricate, in a single layer, 16–32 × 30–45 μ, with outer walls smooth, 0.5–1.0 μ thick, and inner walls verrucose, the warts often in short lines, 2.5–3.0 μ thick; aeciospores yellow, ellipsoidal to subglobose, 15–18 × 19–30 μ, averaging about 16 × 24 μ; walls of aeciospores closely and rather finely to subcoarsely warted, hyaline and 2–3 μ thick.

II. Uredia hypophyllous, pustular, subepidermal, circular to elliptical, 0.2–0.7 mm. in major axis; peridium distinct, 13–16 μ thick; peridial cells in a single layer, angular, thin-walled, 10–13 μ in diameter;

urediospores yellow, catenulate, with intercalary cells, pulverulent, ellipsoidal, rarely subglobose, 12–19 × 18–32 μ, averaging about 16 × 22 μ; walls of spores hyaline, closely and rather finely verrucose, 2.0–2.5 μ thick.

III. Telia on overwintered leaves, hypophyllous, yellow, flat, waxy, rupturing widely at maturity, subepidermal, subcircular to elliptical, 0.3–0.7 mm. in major axis; no peridium; teliospores yellow, catenulate, up to 6 or more in a chain, without intercalary cells, smooth, thin-walled, 11–15 × 12–19 μ. The teliospores germinate in situ at maturity. Basidia slightly curved to strongly arched, 4-celled, 7–8 μ thick and up to 43 μ long. Basidiospores subglobose, 7–9 μ in diameter.

The description of aecia given above is from culture material in Herbarium J. H. Faull: (a) on *Picea glauca* (Moench) Voss (*P. canadensis* [Mill.] B.S.P.), nos. 7305, 7304 and 7302; (b) on *Picea mariana* (Mill.) B.S.P., nos. 7307 and 7308.

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MORPHOLOGY AND ONTOGENY OF THE SPERMOGONIA OF THE MELAMPSORACEAE

LILLIAN M. HUNTER

With plates 182–188

THE MORPHOLOGY and the ontogeny of the spermogonia of rust fungi have thus far received relatively scant attention. Contributions of greater or less significance have been made by Unger (73), Meyer (59), Tulasne (72), DeBary (29, 30), Sappin-Trouffy (66), Blackman (19), Rosen (65), Neuman (60), Maire (55), Allen (3, 5, 6, 8), Ludwig (54), Hunter (45), Jackson (47, 48) and others; but they have been so incidental, fragmentary or introductory in nature that the subject still remains largely unexplored. It would seem that such topics must be of importance with respect to spermogonia just as they are of other reproductive organs, and especially to students of systematic uredinology. Motivated by this viewpoint I have studied the spermogonia of a wide range of species. The paper here presented records part of this work. It is restricted to the Melampsoraceae, and particularly to representatives of the various genera of the Melampsoraceae that occur in temperate North America and Europe.

The material of all *Melampsora* species discussed in this paper was obtained from culture experiments made by W. P. Fraser, J. H. Faull, H. P. Bell, E. H. Moss, G. D. Darker, E. H. Bensley, W. R. Watson and the writer, and from supplementary field material, except that no naturally occurring specimens of *Melampsora Larici-Caprearum* were available.

All of the cultured material, exclusive of that obtained from Professor Fraser, was fixed when in fresh condition. Treatment of the material was similar to that described by the writer (45), with the exception that fresh material of *Uredinopsis, Milesia* and *Melampsora* species was sectioned by hand and studied in an aqueous solution and after mounting in lacto-phenol. A combination differential staining method, using

safranin and light green in lacto-phenol, was introduced for material of *Milesia polypodophila* and *Coleosporium* species after embedding in celloidin. This method was devised without knowledge of Lepik's (52) method of double staining in lacto-phenol. The ethyl-butyl alcohol series was preferable to the ethyl alcohol series used previous to embedding.

The data obtained on each of the species dealt with here are presented in detail with reference to (1) morphology of mature spermogonia, (2) their ontogeny. This procedure has been adopted because of the fact that detailed descriptions of these organs by other authors have been meager at best, and most frequently are non-existent. The species selected belong to the following genera and subfamilies:

I Subfamily MELAMPSOREAE — *Melampsora*
II Subfamily PUCCINIASTREAE — *Melampsoridium, Melampsorella, Pucciniastrum, Thecopsora, Calyptospora, Hyalopsora, Milesia* and *Uredinopsis.*
III Subfamily CRONARTIEAE — *Cronartium*
IV Subfamily CHRYSOMYXEAE — *Chrysomyxa*
V Subfamily COLEOSPORIEAE — *Coleosporium*

From this it will be seen that the only genera of the Melampsoraceae as recognized by Dietel under the family Melampsoraceae (Engler and Prantl's Natürliche Pflanzenfamilien, Band 6, 2nd ed. pp. 35–48, 1928) not included here are *Chnoopsora* and five genera the haploid stages of which are unknown — *Mesopsora, Phakopsora, Crossopsora, Mikronigeria* and *Bubakia.*

I. Subfamily MELAMPSOREAE

The Melampsoreae comprise three genera, namely, *Melampsora, Chnoopsora* and *Bubakia.* Three species of *Chnoopsora* are known; they occur in India and Central Africa; their spermogonia are said to be subepidermal; no material was available for study.

1. **Melampsora Abieti-Capraearum** Tubeuf

Arthur (16) considers *Melampsora Abieti-Capraearum* Tubeuf on *Abies alba* Mill. in Europe and *M. americana* Arthur on *A. balsamea* (L.) Mill. in America to be the same species. My studies on their spermogonia afford support to this conclusion.

The morphology of the spermogonia of the American rust has already been described by Hunter (45). Subsequent examination of additional specimens reveals no essentially divergent data. Quite recently my studies have been extended to the spermogonia of the European rust. The similarities of the American and the European materials

are so close that a summarized presentation of the data for both, as found in Table II below, will suffice. It should be noted, however, that in both of them certainty as to the location of mature spermogonia with reference to the epidermis is often impossible. Some are plainly subepidermal; others appear to be subcuticular. Here then is a case in which the correct description of the spermogonium requires a knowledge of its ontogeny. To clear up this point I have made a thorough study of the ontogeny of the spermogonia of this rust on *A. balsamea*, both from culture and field materials.

The spermogonial primordia in all cases examined lay immediately under and in contact with the epidermis. Usually it forms in an air space (commonly a substomatal cavity), but sometimes between the epidermis and the otherwise contiguous palisade tissue. The primordium consists essentially of closely adhering, vertical, actively growing hyphae, interpreted as spermatiophores, with a suggestion at times of a thin, basal, hyphal mat. Figure 1 (drawn from a lateral, vertical section of a mature spermogonium) adequately illustrates a typical primordium and also initial stages of disruption of overlying epidermal cells. Subsequent developmental stages comprise a thickening of the basal mat (Fig. 2) accompanied by some destruction of underlying mesophyll, and a maturing of the spermatiophores accompanied by a variable amount of destruction of overlying epidermal cells or none at all. These different effects on the epidermis, as revealed by serial sections, may occur within the limits of a single spermogonium.

Destructive action on the mesophyll is indicated in Fig. 3 by a break in the continuity of three layers of its tissues, and by the dark-staining remains of palisade cells embedded in the spermogonium. Among the epidermal cells the guard cells are the most resistant (Fig. 2). They may be invaded; but even so, their thick walls persist and the cells retain their contour. The effect on other epidermal cells is shown in Fig. 1, where it is seen that two hyphae are pushing inwards the lower wall of one cell, and others have already invaded the cell to the right the protoplasm of which is now dead. Almost all conditions of the epidermis overlying a mature spermogonium, as described above, are represented in Fig. 1 of Hunter (45).

The conclusion is that the spermogonium of *M. Abieti-Capraearum* is properly described as subepidermal, and not subcuticular as asserted by Ludwig (54). It consistently originates under the epidermis; and in the course of its development there is more or less destructive action of underlying tissues, and often of the epidermis even out close to the cuticle.

As an addendum it is of interest to note that a few sections showed long hyphae extending beyond the surface of the spermogonium. They were found centrally located in spermogonia that had just matured, never in old spermogonia. Spermatia were massed around them and, unlike paraphyses, they were ephemeral. These I interpret as the "flexuous hyphae" of Craigie (27).

2. **Caeoma Faulliana,** n. sp. O, I.

Pycnidia amphigena, inconspicua, flavida, pustulata, non immersa, hemisphaerica vel conoidea, subcuticularia, 42–145 μ lata et 27–49 μ alta, plus minusve 80 × 37 μ; pycnidiophora simplicia, non septata vel juxta bases septata, ad apicem dehiscentia, poris 12–15 × 23–30 μ. Aecidia hypophylla, maculis flavidis insidentia, secus series duas irregulares disposita, aecidiosporis globosis vel subglobosis, subtiliter verruculosis, 16–21 μ diam.

The material studied was collected by Mr. W. R. Watson on the needles of the current season of *Abies lasiocarpa* (Hook.) Nutt. at Banff, Alberta, July 8, 1925. It consisted of pieces fixed in Carnoy's fluid for study of the spermogonia and dried herbarium specimens (Herb. J. H. Faull, no. 8849). The spermogonia (Fig. 4) at once distinguish this rust from *M. Abieti-Caprearum* which it superficially resembles. They are smaller, more elevated (pustular) and plainly subcuticular. No doubt it is a species of *Melampsora;* but until someone makes appropriate cultures the identity of its diploid phase will remain unknown. So it is tentatively referred to as a new species under the name given above.

3. **Melampsora Abietis-canadensis** (Farl.) Ludwig

The spermogonia of *Melampsora Abietis-canadensis* are borne on leaves of the current season, young cones and young twigs of *Tsuga canadensis* (L.) Carr. The affected leaves, especially those of the terminal buds, may be distorted and Adams (1) states that the same is true for affected twigs. The spermogonia are abundant, small, subcuticular, amphigenous, pustulate, and hemispherical-flattened to conoidal in vertical section (Fig. 6). The base of the spermogonium is a flat-bottomed stroma. The epidermal cells at the base of the spermogonium are separated more or less by mycelium but they are not greatly displaced; they are eventually killed and may be disrupted, though frequently their walls remain unbroken. Thirty-four spermogonia occurring on needles measured from 35–98 μ broad and 15–38 μ high, averaging 66 × 25 μ. On the cones seventy-seven spermogonia measured 53–128 μ broad and 13–30 μ high, averaging 78 × 23 μ. The spermatia are discharged through a long slit, 8–30 μ wide. The foregoing description

is based upon culture material supplied by Professor W. P. Fraser.

Considerable confusion has existed in the past with respect to the identity of *M. Abietis-canadensis* on *Tsuga* (4, 37, 38, 39, 16, 68, 69), but the conclusion as expressed by Ludwig (54) and Arthur (16) is accepted. It is pertinent, however, to call particular attention to a rust (*Caeoma dubium* Ludwig, 54) on *Tsuga heterophylla* (Raf.) Sarg. from western North America. The spermogonia of this rust are distinguished from those of *M. Abietis-canadensis* as well as from other known species of *Melampsora*. The spermogonia of *C. dubium* are subepidermal and measure 80–115 μ broad and 50–90 μ high. This affords another example of the diagnostic value of spermogonia.

4. **Melampsora Bigelowii** Thüm.

The spermogonia of *Melampsora Bigelowii* are found on needles of *Larix laricina* (Du Roi) K. Koch and *L. leptolepis* Murr. They are small, abundant, usually discrete but sometimes confluent, pustulate, amphigenous, subcuticular, and hemispherical to conoidal in vertical sections (Fig. 7). The epidermal cells below the spermogonium, except for slight separation by the mycelium, are usually left *in situ;* but occasionally they are widely separated and sometimes so completely obliterated that the spermogonium occupies the space where the epidermal cells were located, as well as extending above them. Forty-two spermogonia measured 50–102 μ broad and 15–38 μ high, averaging 69 × 27 μ. The spermatiophores may be nonseptate or one-septate towards the base. The spermatia measure 1.5–2.0 × 3–4 μ. The opening through which the spermatia are exuded is 15–30 μ wide and extends over the greater part of the spermogonium in the longitudinal direction of the leaf.

Both spermogonia and caeomata were obtained on *Larix leptolepis* and *L. laricina* from inoculation experiments in which the teliospores of North American species of *Salix* were employed. The material on *L. laricina* only was sectioned.

5. **Melampsora Medusae** Thüm.

The spermogonia of *Melampsora Medusae* occur on needles of *Larix laricina* and *L. leptolepis*. They are indistinguishable from those of *M. Bigelowii*. Both spermogonia and caeomata were obtained on *Larix leptolepis* and *L. laricina* from inoculation experiments in which teliospores from North American species of *Populus* (including *P. tremuloides*) were used. The material on *L. laricina* was sectioned.

6. **Melampsora Larici-Capraearum** Kleb.

The spermogonia of *Melampsora Larici-Capraearum* are borne on needles of *Larix laricina*. They are abundant, small, discrete or occa-

sionally confluent, pustulate, amphigenous, subcuticular and in vertical section conoidal to hemispherical (Fig. 9). The epidermis is somewhat depressed by the overlying spermogonium. Its cells are separated and sometimes killed by the hyphae which have passed through to form the basal stroma. Sometimes the area formerly occupied by these cells is filled with a mass of interwoven hyphae. Thirty-one spermogonia measured 30–101 μ broad and 18–38 μ high, averaging 65 × 28 μ. The spermatiophores may be septate towards their bases. Usually they are single-celled but they may be bicellular and the cells are uninucleate. The spermatia are catenulately produced and they measure 1.5–2.8 × 3–4 μ. The pore through which the spermatia are exuded measures 7.5 × 28.0 μ wide and may extend over the entire length of the spermogonium. Figure 8 represents an immature spermogonium. Here the cuticle may be seen stretched beyond the free ends of the spermatiophores. This condition has been observed frequently.

Spermogonia and caeomata were obtained on *Larix decidua* and *L. laricina* from the European rust in its telial stage on *Salix caprea*. The spermogonia on both species of *Larix* were studied.

II. Subfamily PUCCINIASTREAE

7. **Melampsoridium betulinum** (Pers.) Kleb.

The spermogonia of *Melampsoridium betulinum* occur on needles of *Larix decidua*. They are abundant, minute, amphigenous, subcuticular, pustulate and in vertical section hemispherical flattened to conoidal (Fig. 5). The epidermal cells may remain *in situ* or may be separated by mycelium. The spermogonia measured 45–53 μ broad and 12–15 μ high. The spermatiophores arise from a stroma which forms over the epidermal cells. The opening through which the spermatia are emitted is a slit 8–11 μ wide. The spermogonium of *M. betulinum* is of the same type as that of *Pucciniastrum* species and of such species of *Melampsora* as *M. Bigelowii* and *M. Medusae*.

Arthur (15) reports the haploid stage on *Larix laricina* (Du Roi) Koch from Connecticut and Wisconsin. An examination of specimens from the materials on which the American records are based (supplied through the courtesy of Dr. G. P. Clinton) shows the rust is *Melampsora* sp. True, a few weak peridial cells are present in the aecia but nowhere is there any indication of a well-defined peridium. Since it is now known that fragile, evanescent peridia are present in certain *Melampsora* species, this may account for the confusion which has resulted in error in determination. So far then as verified records go, the haploid stage of *Melampsoridium betulinum* has yet to be found in North America.

In 1898 Klebahn (51) established the genus *Melampsoridium*. He successfully cultured the rust on *Larix* and identified the haploid stage (bearing typical peridermia) with the *Caeoma Laricis* of Plowright (63). The writer has cultured from the telial stage of *M. betulinum* (from *Betula verrucosa*) to *Larix decidua* and *L. laricina*, obtaining scanty infection of both spermogonia and aecia. The latter are true peridermia.

8. **Melampsorella Cerastii** (Pers.) Schroet.

A description of the morphology and of the ontogeny of the spermogonium of *Melampsorella Cerastii* is already recorded by the writer (45) under the name *Melampsorella Caryophyllacearum*. Figure 10 adds an excellent photographic illustration.

9. **Pucciniastrum Epilobii** (Pers.) Otth.

10. **Pucciniastrum Abieti-Chamaenerii** Kleb.

The spermogonia of one of these species, the identity of which was unknown at the time, has already been described by the writer (45) under the name *P. Epilobii*. Subsequently, authentic culture materials of both were made available through the courtesy of Professor Faull, and their spermogonia have been studied in detail. No constant differences were evident. Professor Faull, however, pointed out that there are specific differences in the aecia of the two species, and my examination of his herbarium specimens leads me to the same conclusion.

11. **Pucciniastrum americanum** (Farl.) Arth.

The spermogonia of *Pucciniastrum americanum* occur on leaves of the current season of *Picea glauca* (Moench) Voss. They are small, discrete, amphigenous, irregularly scattered, subcuticular, pustulate, and in vertical section hemispherical flattened in shape. The epidermal cells at the base of the spermogonium are separated by hyphae passing between them into the spermogonium. As the rust nears maturity these cells are somewhat depressed and frequently die; but there is no great disruption of host tissue. Twenty-nine spermogonia were found to measure 71–185 μ broad and 18–62 μ high, averaging 124 × 35 μ.

The spermatiophores are usually either nonseptate or one- to two-septate in the lower third of their length. They branch, just as do those of *P. arcticum* (Fig. 13), from enlarged basal hyphae. The spermatia form catenulately and they measure 1.5 × 3.5 μ in my sections. Measurements of spermatia from fresh material according to Darker (28) are 2.0–2.4 × 3.9–5.9 μ. Frequently the opening through which the spermatia emerge measures 7.5–45.0 μ broad and extends as a slit over the greater part of the spermogonium. The cuticle may curl back exposing a considerable area of the upper surface of the spermogonium. At ma-

turity "flexuous hyphae" have been found extending beyond the tips of the spermatiophores through the opening of the spermogonium.

12. **Pucciniastrum arcticum** (Lagerh.) Tranz.

The spermogonia of *Pucciniastrum arcticum* occur on first year needles of *Picea glauca* and resemble those of *Pucciniastrum americanum* so closely that it is probably impossible to separate them on a morphological basis (Fig. 12). It should be noted, however, that the spermatiophores of *P. arcticum* are commonly one-septate near their bases (Fig. 13). The spermatia, too, are possibly distinctive. In prepared sections they were found to measure 1.5–3.0 × 4.5–6.0 μ. Darker's measurements (28) made from fresh material were 1.3–1.6 × 3.9–4.7 μ.

13. **Thecopsora minima** (Schw.) Syd.

The spermogonia of *Thecopsora minima* are borne on the leaves and young cones of *Tsuga canadensis*. Spermogonia on the leaves only were examined by the writer. They are small, usually discrete but occasionally confluent, amphigenous, irregularly scattered over the leaf surface, subcuticular, pustulate and in vertical section conoidal to hemispherical flattened. Thirty-four spermogonia measured 38–120 μ broad and 15–25 μ high, averaging 79 × 20 μ. The opening through which the spermatia are exuded measures 14–15 μ wide and extends as a slit over the spermogonium for most of its length. The materials studied were obtained from Professor W. P. Fraser. He secured them by inoculating *Tsuga canadensis* with basidiospores from *Rhodora canadensis*.

A difference of opinion exists (37, 16, 38, 39, 64, 1, 70) as to whether or not *T. minima* and *T. Myrtilli* are distinct species. It is doubtful if the spermogonial characters afford any aid in answering this question. It should be added that in all of the experimental work carried on in connection with *Thecopsora minima* and *T. Myrtilli* the infection experiments necessary to prove that the uredial stage on the various telial hosts *Vaccinium*, *Gaylussacia*, *Rhodora* and *Azalea* have never been performed. Gross inoculations with urediospores from one diploid host plant to the other would be of some value; but the experiments should be carried on by inoculating from the telial stages on various hosts to *Tsuga*, and when the aecia are secured inoculations should be made from each source back to all the various telial hosts. It would be well to include *Thecopsora Hydrangeae* in such a set of experiments.

14. **Thecopsora Myrtilli** (Schum.), n. comb.

Aecidium ? Myrtilli Schum.

My study of the spermogonia of *Thecopsora Myrtilli* is based on culture material obtained by Fraser (38) as the result of inoculations from

Vaccinium canadense Kalm on to *Tsuga canadensis* (L.) Carr. No significant differences were found between those of *T. Myrtilli* (Fig. 14) and *T. minima*.

15. **Thecopsora Hydrangeae** (B. & C.) Magn.

The spermogonia of *Thecopsora Hydrangeae* are borne on first year needles of *Tsuga canadensis*. They are small, usually discrete but sometimes confluent, amphigenous, subcuticular, pustulate and in vertical section hemispherical flattened to low conoidal. The stroma of the spermogonium does not usually depress the underlying epidermal cells. Thirty-five spermogonia measured 75–126 μ broad and 15–26 μ high, averaging 99 × 24 μ. The aperture through which the spermatia are discharged is a slit 15–23 μ wide.

16. **Calyptospora Goeppertiana** Kühn

Since an earlier study of the spermogonia of this rust was made by the writer (45) examination of another lot of cultured material confirms the fact that spermatia do not ordinarily form and that the cuticle above the spermogonium remains unbroken. More than five hundred spermogonia have been examined. In these, spermatia were never found to have emerged. In many of the sections mature aecia were present. Frequently the spermogonia are dwarfed. Occasionally growth proceeds little further than is shown in Fig. 11.

17. **Hyalopsora Aspidiotus** (Pk.) P. Magn.

The morphology of the spermogonia of *Hyalopsora Aspidiotus* has already been adequately described (45) and due reference made to Mayor's findings in European material (57). Recently Kamei (50) has described similar but apparently somewhat bulkier spermogonia of his new species *H. aculeata*, cultured by him from *Blechnum Spicant* var. *nipponicum* (K.) M. & K. to *Abies Mayriana* Miy. & Kudo. In continuation of my studies on *H. Aspidiotus* on *Abies balsamea* I am now able to present for the first time an account of the ontogeny of its spermogonia.

The young spermogonium arises subepidermally from a very loosely scattered weft of mycelium in the outer intercellular spaces of the mesophyll (Fig. 16). At a very early stage in its development, hyphae (potential spermatiophores) branch off anticlinally from this weft; and very soon they come to form a continuous layer directly under the epidermis. During the latter process the intervening mesophyll cells are loosened from their connection with the epidermis and they and their neighbors in the outer layer of mesophyll are pressed downward into the spaces below. Frequently a number of the mesophyll cells become in-

volved in the growth of the spermatiophores. They are surrounded and eventually disrupted (Fig. 15). At maturity the epidermal cells above the spermogonium are usually killed; occasionally their walls are broken down by the mycelium (Fig. 16); and at times they may be penetrated by haustoria (Fig. 16). During the formation of the spermogonium the host leaf tissue becomes much swollen (Fig. 15) and drops of tannin and resinous matters form in affected cells — the former being especially abundant in the immediate neighborhood of the spermogonium. Within this region, too, starch grains fill the cells in abnormal amounts.

18. **Milesia intermedia** Faull

In an earlier paper the mature spermogonium of *Milesia intermedia* on *Abies balsamea* was described by the writer (45) under the name *Milesina Kriegeriana* Magnus. Faull (35) has recently shown that the latter is a different species and that it is not known to occur in America. The spermogonia of *M. intermedia*, just as is true of other known Milesian spermogonia, are depressed in the host tissues at maturity. But an examination of mature spermogonia of *M. intermedia*, just as with most species of *Milesia*, leaves one in doubt as to their relation to the epidermis, that is, as to whether they are subepidermal, intraepidermal or subcuticular. To arrive at the correct interpretation in such species ontogenetic studies are necessary. These have been made for several of them by the writer. An account of the ontogeny of the spermogonium of *M. intermedia* follows. It plainly is of subcuticular origin.

The spermogonium of *Milesia intermedia* (Fig. 17) originates in the outer epidermal wall. Hyphae separate the granular layer underlying the cuticle from the wall strata below and growth of the young spermogonium continues in that region. As growth progresses the cuticular and granular strata are elevated and the underlying epidermal cells are depressed.

The formation of the pore in the cuticle, through which later the spermatia are exuded, is of interest. A spermogonium about half developed is shown in Fig. 18. At a central point above the row of spermatiophores, the granular stratum which normally occurs immediately below the cuticle has disappeared. It is at this point that the cuticle breaks, the rupture being caused by pressure exerted by lateral growth of the fungus, and also by the filling of the cavity in the spermogonium with spermatia and spermatial fluid.

At this intermediate stage (Fig. 18) in the growth of the spermogonium the spermatia are well developed. The spermatiophores are fewer and much more separated than in the mature stage. The growth of the spermatiophores is from the stroma. They increase in number by

branching from the cells of the stroma. As the spermatiophores multiply the underlying epidermal cells are pressed more deeply into the host tissue and some of them completely disintegrate.

The mature spermogonium, which, in an early phase was raised and lenticular, is approximately plane with the leaf surface on its outer facies. Its body is hemispherical and deeply immersed as the result of prolific basal growth.

19. **Milesia fructuosa** Faull

Milesia fructuosa was produced in Faull's (36) cultures on various species of *Abies* (Table I), and always on leaves of the first season. In these experiments the rust developed scantily on *A. nephrolepis* Maxim., *A. amabilis* (Dougl.) Forbes and *A. balsamea* and sometimes only spermogonia were borne; on *A. concolor* Lindl. & Gord. the rust was more abundant; but on *A. magnifica* Murr., *A. Fraseri* (Pursh) Lindl. and *A. Fraseri prostrata* Rehd. it was not only abundant but it distorted the leaves of the host. The distorting effect was very marked on *A. magnifica*. The writer studied the spermogonia obtained in these cultures; the results are recorded in Table I.

TABLE I.

Fir host	Number of spermogonia measured	Range in size Breadth × Height in μ	Average size Breadth × Height in μ	Remarks
A. amabilis	8	100–180 × 68–84	134 × 70	Mostly hypophyllous
A. balsamea	17	112–140 × 76–96	137 × 81	Mostly hypophyllous
A. cephalonica	—	Dead areas only	———	
A. concolor	32	80–160 × 52–92	121 × 67	Mostly hypophyllous
A. Fraseri	64	72–152 × 40–100	117 × 76	Mostly hypophyllous
A. Fraseri prostrata	68	88–144 × 40–100	116 × 68	Mostly hypophyllous
A. magnifica	198	80–172 × 48–96	121 × 60	Amphigenous
A. nephrolepsis	6	108–180 × 40–80	132 × 66	Mostly hypophyllous

It will be noted that the measurements for the spermogonia of *M. fructuosa* vary somewhat from those given for *M. intermedia;* yet, if the mean or average measurements of the former are considered, they closely approach those given for the latter. Partly for this reason Faull (36) is inclined to regard these two as the same species (*M. fructuosa*). Certainly their spermogonia are, in general, similar in form and measure-

ments; and both are of subcuticular origin. The greatest aberration was found on *Abies magnifica* — on that host three percent of the spermogonia proved to be subpustulate.

20. **Milesia marginalis** Faull & Watson

The spermogonia of *Milesia marginalis* have been described by Hunter (45), Faull (35) and Arthur (16) as being subcuticular; and that is what mature spermogonia, with very rare exceptions, appear to be. But a study of their ontogeny shows that they originate subepidermally; and then, as development proceeds, by partially breaking down the covering epidermal cells from below, they come to lie in a subcuticular position much as though they had originated directly under the cuticle. Stages shown in this interesting sequence are represented in Figs. 19 21; and the condition at maturity is illustrated in Fig. 23 of this paper and Fig. 10 of an earlier paper by the writer (45).

Figure 19 portrays a spermogonial primordium — a thin mat of hyphae that is separating the epidermis from the underlying layer of mesophyll cells. On its outer facies it has projected haustoria into the epidermal cells and has already begun disintegration of epidermal cellular contents and lower cell walls. Indeed, hyphae now completely occupy a median epidermal cell shown and press against the inner face of its outer wall. The central part of the pad has forced the underlying mesophyll cells downward — the beginning of a process that terminates in a deeply depressed type of spermogonium.

Figure 20 represents a later stage, but a still very young condition of a spermogonium. The spermatiophoric layer is now clearly defined; destructive action from below outwards on the epidermis is proceeding apace; and the depression of the spermogonium into the mesophyll is much more marked.

Figure 21 is drawn from a more advanced stage of an immature spermogonium. All that now remains of the overlying epidermal cells are the cuticle, outer strata of the superior walls and tooth-like portions based on them of the anticlinal partitions. Depression of the basal stroma is continuing, but the final hemispheric form has not yet been attained. Perhaps the most striking new feature is the space now lying between the spermatiophoric layer and the reduced epidermal covering. This is the beginning of a hemispherical, fluid-filled cavity seen in a typical mature spermogonium. As yet spermatia are not forming but migrations of nuclei into the tips of a few of the spermatiophores and appearances of subterminal constrictions indicate that the first spermatia are being organized.

Figure 23 (cf. Hunter, 45) is a good photomicrograph of a section

through a mature spermogonium. Spermatia are being produced abundantly and the central space is doubtless filled with spermatial fluid. The position of the slit through which the spermatia are discharged is evident. It is of particular interest to note that the epidermal membrane consists of the cuticle and a dark-staining layer (the middle of the outer epidermal wall). On the latter are based projections representing middle lamellar substance of the anticlinal partitions.

In conclusion two observations are worthy of record. (1) Very occasionally the overlying epidermis may remain partially (Fig. 22) or wholly intact. (2) A central core of hyphae much longer than spermatiophores has been seen in spermogonia that have reached about three-quarters of their full size. These are interpreted as being "flexuous hyphae," that is, hyphae which possibly are receptive organs with respect to the phenomenon of fertilization.

21. **Milesia polypodophila** (Bell) Faull

The morphology of the spermogonium of *Milesia polypodophila* (Fig. 26) has already been described by Hunter (45). Its ontogeny has not been studied, but note should be made of the fact that "flexuous hyphae" are present at the time the spermogonium has matured (Fig. 24).

22. **Milesia Blechni** (Syd.) Arthur

The spermogonia of *Milesia Blechni* occur on leaves of the current season of *Abies alba* (Fig. 30) and *A. cephalonica* Loud. They are amphigenous but usually hypophyllous, immersed and more or less flask-shaped in vertical sectional view. Nine spermogonia measured 110–175 μ broad and 105–150 μ high. In the absence of ontogenetical studies it is not possible to decide definitely whether they are of subcuticular or subepidermal origin.

23. **Milesia Kriegeriana** (Magnus) Arthur

The spermogonia of *Milesia Kriegeriana* are borne on leaves of the current season of *Abies alba, A concolor* and *A. grandis* Lindl. They are inconspicuous, colorless, abundant, amphigenous, irregularly scattered, subcuticular, immersed, extending well into the mesophyll and hemispherical in sectional view (Fig. 31). No discoloration of the leaf or presence of any lesion can be detected with a hand lens until the spermogonia reach maturity, that is, at the time the spermatial fluid begins to be exuded. Then the affected areas become slightly lighter in color and of a pale yellowish tint. Sixteen spermogonia measured 98–168 μ broad and 94–168 μ high, averaging 129 × 126 μ. The spermatiophores are septate at a distance of about one-third of their length from the base of the spermogonium. They are rarely two-septate. The

cells are uninucleate. The spermatia are catenulate, hyaline and narrowly cylindrical, measuring 1.5–2.0 × 3.5–5.0 μ. They are exuded through a slit-like pore measuring 7.5–15.0 × 25–80 μ. It should be added that while the spermogonia of *M. Kriegeriana* on *A. alba* and *A. grandis* are identical, those on *A. concolor* are shallower on the average.

Mayor (58) describes the spermogonia of *M. Kriegeriana* on *A. alba* as small, rounded, immersed in the tissues and 34–42 μ in diameter — a description so different from that of the writer's that the question arises as to the identity of Mayor's materials.

My studies on the ontogeny of the spermogonia of *M. Kriegeriana* demonstrate their subcuticular origin. Previous to the formation of the young spermogonium, hyphae separate the epidermal cells laterally and then extend periclinally within the outer walls of the epidermal cells. The lateral extensions lie in a plane just below the intermediate wall stratum. Before long the epidermal cells appear to be surrounded by mycelium. The primordial stroma of the spermogonium originates, however, from the layer of mycelium in the outer epidermal wall. Young spermatiophores are formed anticlinally on this stroma. The cuticle is raised above the surrounding leaf surface as in *M. intermedia*. After this stage is reached, basal growth of the spermogonium takes place rapidly. The epidermal cells are depressed and eventually disrupted. The basal stroma expands, the spermatiophores increase in number and the spermogonium as a whole begins to take on a hemispherical form. These processes, accompanied by flattening or destruction of contiguous mesophyll cells, continue until maturity is reached. The eventual form of the spermogonium is very similar to that of *M. intermedia*.

24. **Milesia Polypodii** White

The spermogonia of *Milesia Polypodii* are borne on leaves of the current season of *Abies alba* and *A. concolor*. They are inconspicuous, abundant, amphigenous, subcuticular, colorless, immersed in the mesophyll, in vertical section hemispherical to slightly flask-shaped. No lesion or discoloration of the leaf is present until very shortly before the spermogonia open; then the affected areas become slightly lighter in color and of a pale yellowish tint. Thirty-four spermogonia measured 120–228 μ broad and 105–194 μ high, averaging 177 × 162 μ. They are usually broader than high. The spermatiophores are frequently septate at about one-third of their length from the basal stroma. They may be non-septate or two-septate. The spermatia are narrowly cylindrical, hyaline, catenulate, and measure 1.5–2.0 × 4–5 μ.

Although many of the spermogonia on *Abies concolor* were deeply immersed and reached a size almost as great as those on *A. alba*,

nevertheless, they were frequently found to be raised somewhat above the surrounding epidermis and in such instances were much shallower than the immersed type on *A. alba*. *Milesia Polypodii* on *A. concolor* caused much distortion of the leaves, whereas on *A. alba* there was no noticeable distortion except that the leaf was distended where spermogonia were present. In both hosts the mesophyll cells of the region in which they occur are destroyed in the course of development.

The ontogeny of the spermogonia of *M. Polypodii* was studied from culture materials on *Abies concolor* and *A. alba*. They form essentially in the same way as those of *M. Kriegeriana*. Swollen hyphae separate the mesophyll cells immediately underlying the epidermal cells, and these are also separated laterally from one another by strands of mycelium. Eventually a mat of hyphae, by growth in a periclinal direction, cleaves the outer epidermal cell walls, thus coming to lie just below the layer that consists of the cuticle and the granular stratum. It is mainly from the mat developed in this location that the spermogonium originates. On the upper facies of the mat spermatiophores grow out towards the cuticular covering and the isolated epidermal cells are irregularly distributed near its base. This stage is illustrated in Fig. 25, taken from a spermogonium about one-third grown. When the spermogonium has reached from one-half to two-thirds of its mature size (Fig. 32) a very interesting morphological phenomenon is to be observed. The spermatiophores, not yet fully grown and not sporulating, are present in a semi-circular ring; while much longer, broader, non-tapering, non-septate, uninucleate hyphae, apparently rising from the same stroma as the spermatiophores, form a central core. The spermatiophores stain very deeply in contrast with the hyphae of this core. At an earlier stage in development than that just described, the central core of hyphae may be in contact with the overlying membrane of the host; but it soon becomes separated and when the "slit" is formed the hyphae of the core emerge and grow out 20 μ or more beyond the covering of the spermogonium. Sections of nearly mature spermogonia in which the spermatia have formed, but in which the cuticle is not yet ruptured, show that the spermatia have no particular tendency to cling to the long hyphae; but once the spermogonium has ruptured and there has been opportunity for contact with spermatia from other spermogonia the long hyphae may be found with spermatia attached. The dark band lying over the spermogonium shown in Fig. 33 is made up of spermatia apparently massed around the long hyphae. Occasionally a hypha is seen protruding from among the exuded spermatia and sometimes one can be recognized when cut transversely in section. Just what these long

hyphae are is not certain, but according to my interpretation they are "flexuous hyphae" as described by Craigie (27) for certain Pucciniaceae.

25. **Milesia Scolopendrii** (Fuckel) Arthur

The spermogonia of *Milesia Scolopendrii* are borne on leaves of the current season of *Abies alba* and *A. concolor*. They are inconspicuous, amphigenous, apparently subcuticular, colorless, immersed in the mesophyll, in vertical section conspicuous and hemispherical to slightly flask-shaped. Twenty-eight spermogonia measured 120–228 μ broad and 100–188 μ high, averaging 156 × 140 μ. These measurements are within close range of those given for *M. Polypodii* and it is difficult to distinguish these rusts by their spermogonia. The spermatiophores are usually one- or two-septate near their bases; but occasionally they are entire. The spermatia are catenulate, hyaline, narrowly cylindrical, 1.5–2.0 × 4–5 μ. The opening through which they are exuded measures 5–38 × 40–110 μ.

No early stages in the development of the spermogonia were studied. But interesting observations were made on "flexuous hyphae" in mature or submature spermogonia. Spermogonia, twenty-seven to thirty days following inoculation on *Abies alba* and from which spermatia were just beginning to discharge, contained unusually long "flexuous hyphae" protruding far beyond the apical "slit." Hand sections of fresh material were made, then mounted in water, and finally preserved in lactophenol tinted lightly with acid fuchsin stain. Some of the "flexuous hyphae" in these sections were turgid and filled with cytoplasm, while others appeared empty and flaccid. One section was of especial interest (Figs. 28, 29). In it the spermatiophores were of normal length and spermatia were present; but standing out in the central cavity there was a long flexuous hypha with spermatia attached, extending slightly beyond the aperture and about 105 μ beyond the tips of the spermatiophores (Fig. 27). Another hypha was present to which spermatia were also attached, and these, as in the former instance, had remained adherent throughout the processes of washing and staining. In this same section there were at least six other "flexuous hyphae" in various conditions of turgidity or flaccidity. It may be added that "flexuous hyphae" were never found in old spermogonia. While the writer is not prepared to venture an opinion on the part played, if any, by "flexuous hyphae" in the sexual phenomena of rusts, yet, in continuation of such studies as have been made on this topic by Craigie (24–27), Pierson (62), Andrus (10) and Allen (7–9) it is suggested that species of *Milesia* would appear to afford excellent material. Their spermogonia are relatively large, they lack confusing paraphyses and they produce striking "flexuous hyphae."

26. **Milesia vogesiaca** (Sydow) Faull

The spermogonia of *Milesia vogesiaca* (Fig. 34) occur on leaves of the current season of *Abies alba*. They are inconspicuous, very abundant, amphigenous but mostly epiphyllous, apparently subcuticular, plane on the upper surface, deeply immersed in the mesophyll, and in vertical section spherical to slightly flask-shaped. Thirty-four spermogonia measured 154–241 μ broad and 168–214 μ high, averaging 201 × 195 μ. The spermatiophores branch from enlarged hyphal cells of the stroma which forms the base of the spermogonium. They are usually one-septate towards their bases but they may be two-septate, the second septum being about one-third of the length of the spermatiophore from its base. The spermatia are narrowly cylindrical, hyaline, 1.5–2.0 × 4–5 μ. The opening through which they are exuded is a slit-like pore in the cuticle, 5–35 × 30–70 μ. "Flexuous hyphae," 6–9 μ in diameter, occur in mature or submature spermogonia.

The spermogonia of *M. vogesiaca* are much larger than those of any of the other European species of *Milesia*. They more nearly approach those of *M. polypodophila* in size, although the latter are generally larger. The spermogonia of *M. polypodophila* are subspherical, being elongated slightly along the vertical axis; while those of *M. vogesiaca*, also subspherical, are most frequently slightly elongated along the horizontal axis. Moreover, the spermogonia of *M. polypodophila* are distinctly subepidermal and also differ from those of *M. vogesiaca* in their much longer incubation period. Confusion as to the position of the latter in the host may result because the subcuticular area above the spermogonium is so narrow that in a lateral section there is an appearance of being subepidermal. Ontogenetic studies alone can determine whether or not the spermogonia are really of subcuticular origin.

27. **Peridermium rugosum** H. S. Jackson

The morphology of *Peridermium rugosum* was described by the author in an earlier paper (45).

28. **Uredinopsis mirabilis** (Peck) Magnus

The spermogonia of *Uredinopsis mirabilis* occur in *Abies balsamea* on leaves of the current season. They are inconspicuous, rarely confluent, hypophyllous, subcuticular, colorless, immersed in the mesophyll, in vertical section hemispherical and either quite flat on top, slightly raised above the surrounding epidermis or, in late maturity, centrally depressed. Forty-nine spermogonia measured 58–123 μ broad and 35–54 μ high, averaging 89 × 44 μ. The same condition which exists in *Milesia intermedia* is found in *U. mirabilis*, namely, the combined cuticle and

the intermediate wall layer remain over the spermogonium at maturity. The spermatiophores are one-septate, or occasionally two-septate, towards their bases. The basal cells are long and tubular, narrowing toward their upper ends. Formerly (45) this was thought to be an aid in distinguishing *Uredinopsis* species from *Milesia* species; but equally large basal tubular cells have since been found in the spermatiophores of *Milesia* species. The spermatia are oval, hyaline, catenulate and measure 1.5–2.0 × 3.5–4.2 μ. The opening in the cuticle through which they are exuded is a pore or short slit, 4–9 × 10–40 μ.

Doubt has existed as to whether the spermogonia of this and various other species of *Uredinopsis* are subcuticular or subepidermal. Thus Arthur (15), in referring to the mature spermogonia of *Uredinopsis*, speaks of them as "extending between and depressing the tissues beneath, giving the appearance of being subepidermal." Indeed, it seems from the mature spermogonia as if this might be the case; but investigations of the earlier phases of their development in *U. mirabilis* show them to arise in a subcuticular fashion. After a certain amount of growth, the haploid mycelium begins to be directed towards the leaf surface and passes between the cells, along the middle lamellae, occasionally completely separating the epidermal cells from one another. Then the hyphae grow laterally and separate the outer epidermal wall into two layers. There is an interweaving of these hyphae and a stroma is organized; simultaneously, branches of mycelium from the stroma are sent out anticlinally and gradually the cuticle is raised. At the same time the underlying epidermal cells are slightly depressed due to pressure from the growth of the developing spermogonium. Figure 35 is an illustration of an early stage in the development of the spermogonium. It shows that the epidermal cells at the base have been separated and at least partly surrounded by the mycelium.

Although in its very early stages the spermogonium is superficial and raised above the epidermis, it later becomes immersed in the leaf tissue. The young spermatiophores increase in number and lengthen. The epidermal cells gradually become crushed and finally they may disappear entirely. Usually the mesophyll cells immediately underlying the spermogonium are pushed downward into the leaf, probably filling up an intercellular space; occasionally they may be involved in the growth of the stroma and disappear. As the spermogonium becomes immersed the overlying cuticle resumes its former position and is more or less on a level with that covering the surrounding epidermis.

29. **Uredinopsis Atkinsonii** Magn. (Fig. 36)

30. **Uredinopsis Osmundae** Magn.

31. **Uredinopsis Phegopteridis** Arthur

32. **Uredinopsis Struthiopteridis** Störmer

The spermogonia of all the four preceding species except *Uredinopsis Struthiopteridis,* have already been described by the writer (45). All resemble those of *U. mirabilis* so closely that these species cannot be distinguished from one another by their spermogonia. A recapitulation of their morphological data is found in Table II.

33. **Uredinopsis Pteridis** D. & H.

Little can be added to the account of the spermogonia of *Uredinopsis Pteridis* already given by Hunter (45) except to say that the literature on *U. Pteridis* and *Peridermium pseudo-balsameum* Arthur and Kern is a maze of confusion (cf. Schmitz, 67; Weir and Hubert, 74; Rhodes, Hedgcock, Bethel and Hartley, 64; Hunter, 45; Kamei, 49).

34. **Peridermium balsameum** Peck

Peck (61) discovered a white-spored rust on the leaves of *Abies balsamea* Mill., which in 1875 he named *Peridermium balsameum.* For many years, as pointed out by Faull (34), this name has been applied to the aecial stage of various North American species of the two genera *Milesia* and *Uredinopsis.* Fraser (38) was the first to demonstrate that five species of *Uredinopsis,* namely, *U. Struthiopteridis, U. Osmundae, U. Atkinsonii, U. Phegopteridis,* and *U. mirabilis* have their aecial stage on *Abies balsamea.* He considered that the peridermia of all of these would pass current for the *P. balsameum* of Peck. The occurrence of these five species on *Abies* was later confirmed by culture experiments carried out under the direction of Professor Faull (34). The Sydows (70) in referring to Fraser's work stated that the peridermia of the various North American species of *Uredinopsis* recorded in their Monographia cannot be distinguished from Peck's *P. balsameum* but they cite *P. balsameum* as a synonym of *U. Struthiopteridis* only. Arthur (15) chose to refer *P. balsameum* to *U. mirabilis;* but he also stated that the aecial stages of *U. Osmundae* and *U. Copelandi* Sydow are similar to those of *U. mirabilis.* Arthur and Kern (17) redescribed *P. balsameum* Peck. Their material comprised numerous specimens, including what they considered Peck's type material from the Adirondack Mts. and without realizing that in it more than one species was involved. Incidentally they ventured the opinion that *Aecidium pseudocolumnare* Kühn, as maintained by Farlow, might be identical with *P. balsameum.*

Faull (34) discovered that three American species of the genus *Milesia* on *Abies balsamea,* as well as those of *Uredinopsis,* occur on the leaves of *Abies balsamea.* Of these, *M. polypodophila* (Bell) Faull,

easily distinguished from the others by the occurrence on leaves 3-8 years old and by its strikingly distinctive morphological characters, apparently had been overlooked by collectors; but the remaining species referred to by him and occurring on leaves of the current season (as do those of the *Uredinopsis* species mentioned), had no doubt passed under the name *P. balsameum*.

It is now known that the genera *Milesia* and *Uredinopsis* in North America, as they occur on *Abies*, can be distinguished from one another by their spermogonia, and that similarly the species *Milesia intermedia* (perhaps more properly named *M. fructuosa* Faull), *M. marginalis* and *M. polypodophila* possess specifically distinctive spermogonia (45). Hence it is now possible to more exactly determine the identity of what Peck himself preserved in his herbarium under the name *Peridermium balsameum*. With this object in view the writer has critically examined Peck's collections stored in the Herbarium of the New York State Museum at Albany, N. Y. and made available through the courtesy of Dr. H. D. House.

The writer found two sheets of exposed specimens and two packets, all ascribed to Professor Peck as collector. There are various later collections in the Herbarium but these are not of pertinent interest here. The first sheet, regarded as the oldest (dating back possibly to 1873), carries several exposed specimens and bears the label, "*Peridermium balsameum* Peck, Adirondack Mts., New York State, July and Aug." Presumably it is the type sheet, though neither it nor any other is so marked. The specimens on this sheet prove to be predominantly *Milesia intermedia;* but one of them is a species of *Uredinopsis*. The second sheet, with several specimens mounted similarly to the first, bears the label, "*Peridermium balsameum* Peck, Charlotteville Swamp, N. Y. State, Aug." It is *M. intermedia*. The third collection was made at N. Elba, N. Y. State, in Aug. 1910, according to the label; it is also *M. intermedia*. The fourth collection is recorded as from L. Avalanche, Adirondacks, N. Y., dated Aug.; but as with the first two sheets, no mention is made of the year. It is a species of *Uredinopsis*.

The writer's conclusions are: (1) Peck's own collections of white-spored peridermial rusts on *Abies* comprised species of both *Milesia* and *Uredinopsis*, and were designated by him as *Peridermium balsameum;* (2) *P. balsameum* cannot accurately be designated as a synonym of any particular species of *Uredinopsis*, as has been done by Sydow and Arthur; (3) what is possibly the type sheet of Peck's *P. balsameum* carries a large proportion of *Milesia intermedia* but some material of an undeterminable species of *Uredinopsis*.

In the study of these plants serial sections were made of selected leaves, and comparisons were made with similar preparations from authentic materials (obtained from controlled cultures) of the various species of *Milesia* and *Uredinopsis* mentioned above, made available through the kindness of Professor Faull.

35. **Aecidium pseudocolumnare** Kühn

The first collections of *Aecidium pseudocolumnare* were made by Kühn in the Black Forest, Germany, in August and September, 1883. The spermogonia were not described but a detailed description of the aecia and aeciospores was given on labels attached to herbarium specimens. The aeciospores were said to be white, finely warted and to measure 18.5–25.7 μ broad and 22.8–37.2 μ long. Winter (76) in 1884 published the description of this *Aecidium* word for word with the description signed by Kühn. Kühn's collections were distributed in Rabenhorst-Winter, Fungi Europaei under the name of *Aecidium pseudocolumnare* J. Kühn, nov. sp. number 3027. It is taken for granted then that this material represents the type for *A. pseudocolumnare*. This name, however, came into general use in Europe as a designation of white-spored peridermia on *Abies alba*. That this has been done uncritically is illustrated by the results of comparative examinations made by the writer of spermogonia from several collections found in the herbaria of the Royal Botanic Gardens, Kew, and the British Museum of Natural History — all regarded as *A. pseudocolumnare*. Aeciospores and peridial cells did not prove sufficiently characteristic to be of diagnostic value. Descriptions of the spermogonia of the various collections follow:

(1) Rabenhorst-Winter, Fungi Europaei no. 3027, *Aecidium pseudocolumnare* J. Kühn, nov. sp. (bearing Kühn's original description). The spermogonia from this collection are subepidermal and measure 160–200 μ broad and 152–180 μ deep. They closely resemble those of *Milesia vogesiaca*.

(2) Krieger, Schädliche Pilze unserer Kulturgewächse no. 74, *Aecidium pseudocolumnare* J. Kühn. The spermogonia are subcuticular and measure 92–140 μ broad and 112–160 μ deep. They most closely resemble those of *Milesia Kriegeriana*.

(3) Krieger, Fungi Saxonici no. 1419, *Aecidium pseudocolumnare* Kühn nov. sp. Very little of this material was available but enough was obtained to show a few subcuticular spermogonia measuring 130–132 μ broad and 92–120 μ deep. They also resemble those of *Milesia Kriegeriana*.

(4) C. E. Broome, *Peridermium columnare* on *Picea Nordmanniana* (*Abies Nordmanniana*), Torquay, ex Herb. M. J. B. Aug. 1867. According to J. Ramsbottom, Keeper of Botany, British Museum of Natural History, this material is originally from the herbarium of Miles Joseph Berkeley. Ten spermogonia from a fragment of the specimen were examined. Nine of these are definitely subcuticular while one is subcuticular only in the center with remains of epidermal cells at the sides overlying the spermogonium. They measure 152–208 μ broad and 140–200 μ deep. The evidence is that the subcuticular spermogonia may belong to either or both *Milesia Polypodii* and *M. Scolopendrii.*

(5) M. C. Cooke, Fungi Britannici exsiccati no. 314, *Peridermium columnare* A. & S., near Torquay, Sept. 1869. E. Parfitt. The spermogonia are deep-seated, subcuticular, measuring 128–180 μ broad and 132–180 μ deep. They also may be referable to either or both *Milesia Polypodii* and *M. Scolopendrii.*

(6) *Aecidium pseudocolumnare* Kühn on *Abies alba.* Kelso, Aug. 1925, Malcolm Wilson. Only a small fragment of an infected needle was examined. The sections were not sufficiently satisfactory to warrant a definite conclusion, since the spermogonia seemed to be distorted. They are deep-seated, large, hemispherical, subcuticular and probably belong to the genus *Milesia.*

(7) *Aecidium pseudocolumnare* Kühn. Powerscourt, Co. Wicklow, P. O'Connor. One collection is dated 11.11.31 and 6.2.31, while a second collection is dated 11.11.31. Although this material was collected late in the year, it is in excellent condition. The peridermia even in the dried state are long and unbroken, and almost every leaf on a branch of considerable size is rusted. For convenience the two collections are referred to respectively as (a) and (b). Two spermogonia examined from (a) are deep-seated, hemispherical and measure 101 μ broad and 168 μ deep. These most closely resemble the spermogonia of *Milesia Kriegeriana.* Four spermogonia from (b) were examined. They are deep-seated, subepidermal, elongate and measure 174–181 μ broad and 181–188 μ deep. They closely resemble spermogonia of the type material of *Aecidium pseudocolumnare.*

A study of the spermogonia in these collections, therefore, clearly indicates that the latter are referable to several distinct species. Hence, just as in North America, until recently, several white-spored rusts on *Abies* have been passing under the name *Peridermium balsameum* Peck, so it would seem that the same is true in Europe for *Aecidium pseudocolumnare.*

III. Subfamily CRONARTIEAE

36. **Cronartium ribicola** Fischer

The spermogonia of *Cronartium ribicola* occur on *Pinus Strobus* L. and other five-needle pines. They are caulicolous, subcortical, forming small blisters. They are located between the outermost layer of cortical cells and the periderm, effuse or indefinite in type. Six spermogonia measured 1.0–3.5 mm. broad and 34–67 μ high. Figure 38 represents a mature spermogonium. Sydow (70) states that the spermogonia are about 2.5 mm. long. Colley's (22) observation that "occasionally long filaments grow some distance out beyond the tips of the spermatiophores" is of especial interest when viewed in the light of recent discoveries in connection with the fusion of spermatia and haploid hyphae. The spermatia according to Colley are pyriform and measure approximately 2.5 × 3.5 μ.

IV. Subfamily CHRYSOMYXEAE

37. **Chrysomyxa Ledi** (A. & S.) DeBary

The spermogonia of *Chrysomyxa Ledi* occur on first year needles of *Picea mariana* (Mill.) B. S. P. and *P. glauca* (Moench) Voss. They are amphigenous, subepidermal and flask-shaped in section (Fig. 37). If the spermogonium happens to form below a stoma the guard cells are carried above the spermogonium. Frequently the epidermal layer, though raised slightly, is left intact; but sometimes the lower walls are attacked and the cells killed. The hypodermal cells within the area of the spermogonium are disrupted, and disappear. The mesophyll cells below the spermogonium are depressed. Twenty-nine spermogonia measured 60–128 μ broad and 45–125 μ high, averaging 105 × 82 μ. The spermatiophores arise from a basal stroma and are directed to a slit-like pore in the epidermis. They are usually one-septate near their bases. The spermatia measure 1.5–2.0 × 3.0–3.5 μ. They are slightly elongate and form catenulately. The pore through which they are emitted measured 4–35 μ broad and 20–80 μ long.

V. Subfamily COLEOSPORIEAE

38. **Coleosporium Helianthi** (Schw.) Arth.

The spermogonia of *Coleosporium Helianthi* are borne on leaves of *Pinus virginiana* Mill. and *P. echinata* Mill. They are numerous, amphigenous and of the applanate, lenticular type; they resemble those of *Hyalopsora Aspidiotus* in shape except that they are elevated more above the surrounding epidermis and do not depress as much the mesophyll cells of the leaf at maturity. The spermogonia form between the mesophyll and the overlying tissues. The latter consist of an

epidermis, a hypodermis and from one to two layers of thick-walled cells irregularly placed under the hypodermis. The spermogonia are most frequently discrete; but they are sometimes confluent. Twelve spermogonia measured 323–458 μ broad and 92–116 μ high, averaging 361 × 103 μ. The spermatiophores are usually single-celled. The spermatia are discharged through a slit 34–92 μ wide. A mature spermogonium showing its relation to the leaf is represented in Fig. 39. In addition to other features, attention should be drawn to long, centrally located hyphae that extend beyond the spermatiophores and the level of the epidermis. These are "flexuous hyphae." Such hyphae may extend as much as 15 μ beyond the epidermal level. When the spermogonia have passed full maturity and the spermatia have been discharged there is no trace left of these hyphae. (cf. Arthur 12, 14, Hedgcock 42, Hedgcock and Hunt 43.)

The materials for the study of this and the other species of *Coleosporium* described below were kindly supplied by Dr. G. G. Hedgcock.

39. **Coleosporium inconspicuum** (Long) Hedgc. & Long

The spermogonia of *Coleosporium inconspicuum* are borne on leaves of *Pinus virginiana* etc. The same general description of form and location applies as for the spermogonia of *C. Helianthi*, except that the spermatiophores are of slightly smaller diameter. Eleven of them measured 226–317 μ broad and 73–85 μ high, averaging 284 × 81 μ.

The immature spermogonium of *C. inconspicuum* depresses the mesophyll cells lying immediately under it; whereas in the mature spermogonium the latter have regained their normal position with the exception that they may be separated by the strands of mycelium. The cells above the young spermogonium (Fig. 40) are raised and flattened; but on either side of the spermogonium they have retained their normal size and position. Differential staining shows that two layers of mesophyll cells immediately under the spermogonium, in contrast with those more distantly located, have in some way been affected by the parasite. (cf. Arthur 14, Hedgcock 42, Hedgcock and Hunt 43.)

40. **Coleosporium Ipomoeae** (Schw.) Burr.

The spermogonia of *Coleosporium Ipomoeae* occur on needles of *Pinus rigida* Mill. etc. They are subepidermal and of the applanate type. They measure 335–490 μ broad and 104–159 μ high. According to Hedgcock (42) they are olivaceous-black to brownish-black, on slightly chlorotic areas. They are amphigenous in *P. rigida* and hypophyllous in *P. echinata*.

41. **Coleosporium delicatulum** (A. & K.) Hedgc. & Long

The spermogonia of *Coleosporium delicatulum* occur on needles of *Pinus rigida* etc. They are amphigenous, subepidermal, applanate, and measure 354 μ broad and 110–122 μ high. According to Hedgcock (42) they are orange chrome to English red on reddened chlorotic areas.

42. **Coleosporium Laciniariae** Arth.

The spermogonia of *Coleosporium Laciniariae* occur on needles of *Pinus rigida* etc. They are discrete, epiphyllous, subepidermal, applanate and measure 323–397 μ broad and 110–122 μ high. According to Hedgcock (42) they are olive to olivaceous-black on yellow chlorotic areas. The spermatiophores usually are one-septate towards their bases.

43. **Coleosporium Solidaginis** (Schw.) Thüm.

The spermogonia of *Coleosporium Solidaginis* are borne on needles of *Pinus rigida* etc. They are usually discrete. They measure 244–366 μ broad and 98–104 μ high. In *P. rigida* they are hypophyllous. According to Hedgcock (42) they are grenadine red on slightly reddened chlorotic areas.

44. **Coleosporium Terebinthinaceae** (Schw.) Arth.

The spermogonia of *Coleosporium Terebinthinaceae* occur on needles of *Pinus virginiana* etc. They are epiphyllous and measure 335–427 μ broad and 80–101 μ high. According to Hedgcock (42) they are "orange rufous to mummy brown, on yellowed chlorotic areas."

45. **Gallowaya pinicola** Arth.

The spermogonia of *Gallowaya pinicola* occur on the leaves of *Pinus virginiana*. They are of the applanate type, lenticular in vertical section, subepidermal and amphigenous. Seven spermogonia measured 244–427 μ broad and 48–92 μ high. Figure 41 represents a mature spermogonium. The spermogonia are nearly always centrally located beneath the guard cells in stomatal cavities and develop between the mesophyll and the epidermis. The underlying mesophyll cells are not usually depressed and the overlying epidermis is very slightly elevated. The contiguous epidermal cells are never flattened as they may be in *Coleosporium* species; but differential staining shows that their lower walls have been affected by the fungus. The stroma is made up of interwoven hyphae overlying the mesophyll cells; from it spermatiophores branch and are arranged periclinally, curving slightly towards a central point under the epidermis. The spermatiophores are attenuate, frequently curved at their tips and usually one-septate, about one-third up from the base. Spermatia do not form.

Arthur (16) places *Gallowaya pinicola* in the genus *Coleosporium*. He states that the spermogonia are rudimentary and not externally visible; Dodge (32) previously described them as vestigial or abortive. Dodge further stated that host tissues above the spermogonia are not fully ruptured and that spermatia are seldom formed. Here we have a parallel case to that of *Calyptospora Goeppertiana*. In *G. pinicola* then, as in *C. Goeppertiana*, the spermogonia cannot function in the way described for *Puccinia* species by Craigie (27).

CONCLUSIONS AND SUMMARY

1. The morphology of the spermogonia of representatives of all the genera, except *Chnoopsora*, of the Melampsoraceae (Dietel, 1928) has been studied in the course of the investigations recorded in this paper.

2. From these studies it is amply demonstrated that spermogonia are of more or less diagnostic value (just as are other organs) in defining or determining species and genera. The features of chief importance in that connection are the form-type, size and position in the host tissues. It should, of course, be recognized that these features can be employed in diagnosis with greater assurance where the complete life history is known and where the spermogonia have been studied and defined from authentic culture material. This may be illustrated by reference to those species of Melampsoraceae whose haploid stages occur on the Pinaceae. In eastern North America the life histories of many of them have been worked out and the spermogonia have been studied from authentic culture material. It so happens that the *aecial* characters of many of these species are not sufficiently distinctive to enable one to recognize the species or in some cases even the genus from haploid material. The *spermogonial* characters, on the other hand, in many such instances have proved to be of diagnostic value and their characters have been incorporated in definitions of the species. It is now possible, therefore, to recognize many of the Melampsoraceae in eastern North America from haploid material alone and without having recourse to cultures. As for western North America, by contrast, little work has been done on life histories of coniferous rusts. An examination of the spermogonia in western collections of coniferous rusts shows that the spermogonia of some of these rusts are surely of diagnostic value; but the delimitation of species is bound to be tentative until life histories are worked out and the exact morphological characters of their spermogonia are incorporated in descriptions of the species. Much the same condition prevails with respect to the European Melampsoraceae.

3. The spermogonia of the Melampsoraceae may be classified according to their form and position in the host tissues, as follows:

A. *Subcuticular* — (a) pustulate — (1) hemispherical to conoidal
(b) immersed — (1) hemispherical; (2) subspherical to spherical

B. *Subepidermal* — (a) applanate
(b) immersed — (1) elliptical; (2) spherical to flask-shaped

C. *Subcortical*

4. Spermogonia have been found for the main part to be characteristic in type for each genus. The one outstanding exception is that of *Melampsora*. In *Melampsora*, as now commonly recognized, two very diverse types of spermogonia are comprised — (1) species in which the spermogonia are robust and deep-seated; (2) species in which the spermogonia are small and pustulate.

Another feature in this connection refers to the importance of giving attention to the spermogonia in surmises as to the genetic position of coniferous rusts where the life histories are unknown. This may be illustrated in such a rust as *Peridermium coloradense*. Certain uredinologists have suggested that it is the haploid stage of a *Melampsorella;* indeed, some have gone so far as to refer it to *Melampsorella Cerastii* (75, 16). An examination of the spermogonia of this rust shows that it cannot possibly be a *Melampsorella*. Its type is that of a *Chrysomyxa*.

5. The spermogonia are of value in establishing or confirming views as to the phylogenetic relationship of genera. An excellent example of this is afforded by the genera *Milesia* and *Uredinopsis*. The similar characters of their spermogonia lend support to the view that these genera are closely related. Another example is afforded by *Pucciniastrum, Thecopsora, Calyptospora* and *Melampsoridium*, in all of which the spermogonia are morphologically similar.

6. Spermogonia have, as indicated above, been found to be of value in the determination of species from haploid material; in some such instances no help is afforded by aecial characters. For example — *Melampsora americana* and *Caeoma Faulliana; Milesia intermedia, M. marginalis* and certain other species of *Milesia* as distinct from one another and from species of *Uredinopsis;* and *Calyptospora Goeppertiana* as distinct from various species of *Pucciniastrum*.

7. Attention is called to the non-spermatia-forming rusts, *Calyptospora Goeppertiana* and *Gallowaya pinicola*, as examples of rusts in which spermatia cannot take part in initiating the diploid phase such as is presumed to be the case for *Puccinia graminis, P. Helianthi* etc.

8. The ontogeny of the spermogonia has been studied more or less completely for the following species — *Melampsora Abieti-Capraearum, M. Larici-Capraearum, Melampsorella Cerastii, Calyptospora Goeppertiana, Hyalopsora Aspidiotus, Milesia intermedia, M. marginalis, M. Kriegeriana, M. Polypodii, Uredinopsis mirabilis, U. Atkinsonii, U. Osmundae* and *Coleosporium inconspicuum*.

The value of the ontogenetical studies of some species lies in the circumstance that it is only in this way that the exact type can be determined. Thus a mature spermogonium may appear to be subcuticular when it is really subepidermal or subepidermal when it is really subcuticular.

9. The spermogonia of the Melampsoraceae lack paraphyses. But "flexuous hyphae," possibly receptive organs, extending beyond the aperture of the spermogonium have been found in numerous species of the Melampsoraceae, namely, *Milesia marginalis, M. polypodophila, M. Kriegeriana, M. Polypodii, M. Scolopendrii, M. vogesiaca, Melampsora Abieti-Caprаearum* and *Coleosporium Helianthi*. In *Milesia Scolopendrii* spermatia were occasionally attached to "flexuous hyphae" but the nature of the connection was not determined. "Flexuous hyphae" are greater in diameter for most of their length than spermatiophores and are not so much attenuated.

10. Branching of spermatiophores from the stroma has been demonstrated for *Uredinopsis Atkinsonii* and *Pucciniastrum arcticum*. During the development of the spermogonium the distal ends of the spermatiophores remain free from the overlying epidermis or cuticle. At their maturity the spermatiophores are only about one-half the length of the "flexuous hyphae." The spermatiophores decrease in length as they age. Their cells are always uninucleate. Spermatia are borne catenulately. The "slit" through which spermatia are discharged is, in general, parallel to the long axis of the leaf on which the spermogonium is borne.

11. One new species, *Caeoma Faulliana,* is described in this paper.

12. Morphological data on the spermogonia of the species herein studied are summarized below in tabular form (Table II).

TABLE II

SPERMOGONIA OF MELAMPSORACEAE*

Species	Shape (vertical section)	No. measured	Size (breadth × height in microns) Limits	Average	Remarks
I. SUBFAMILY MELAMPSOREAE					
Melampsora Abieti-Capraearum (M. americana)	Elliptical	67	79–154 × 42–71	99 × 48	Subepidermal, depressed
Melampsora Abieti-Capraearum	Elliptical	54	83–138 × 45–67	110 × 54	Subepidermal, subdepressed
Caeoma Faulliana	Hemispherical to conoidal	45	42–145 × 27–49	80 × 37	Subcuticular, pustulate
Melampsora Abietis-canadensis	Hemispherical flattened to conoidal	34	35–98 × 15–38 (on needles)	66 × 25	Subcuticular, pustular
		77	53–128 × 13–30 (on cones)	78 × 23	
Melampsora Bigelowii	Hemispherical to conoidal	42	50–102 × 15–38	69 × 27	Subcuticular, pustulate
Melampsora Medusae	Hemispherical to conoidal	17	51–105 × 15–30	75 × 23	Subcuticular, pustulate
Melampsora Larici-Capraearum	Hemispherical to conoidal	31	30–101 × 18–38	65 × 38	Subcuticular, pustulate
II. SUBFAMILY PUCCINIASTREAE					
Melampsoridium betulinum	Hemispherical flattened to conoidal	—	45–53 × 12–15	———	Subcuticular, pustulate
Melampsorella Cerastii	Hemispherical flattened	72	99–317 × 27–59	184 × 38	Subcuticular, pustulate
Pucciniastrum Epilobii	Hemispherical flattened	81	45–212 × 16–34	95 × 21	Subcuticular, pustulate
Pucciniastrum Abieti-Chamaenerii	Hemispherical flattened	35	67–196 × 16-31	102 × 23	Subcuticular, pustulate

Notes: 1. Spermogonia on leaves of current season except as indicated under "Remarks".
2. Spermogonia "amphigenous" except as indicated under "Remarks". The term "amphigenous" is used here if spermogonia have been found on both upper and lower leaf surfaces regardless of whether or not they may usually be restricted to one surface or the other.

TABLE II. (Continued)

Species	Shape (vertical section)	No. measured	Size (breadth × height in microns) Limits	Average	Remarks
II. SUBFAMILY PUCCINIASTREAE. (Continued)					
Pucciniastrum americanum	Hemispherical flattened	29	71–185 × 18–62	124 × 35	Subcuticular, pustulate
Pucciniastrum arcticum	Hemispherical flattened	29	100–167 × 22–51	142 × 32	Subcuticular, pustulate
Thecopsora minima	Hemispherical flattened to conoidal	34	38–120 × 15–25	79 × 20	Subcuticular, pustulate
Thecopsora Myrtilli	Hemispherical to conoidal	15	41–105 × 15-23	72 × 20	Subcuticular, pustulate, hypophyllous
Thecopsora Hydrangeae	Hemispherical flattened to conoidal	35	75–126 × 15–26	99 × 24	Subcuticular, pustulate
Calyptospora Goeppertiana	Hemispherical to conoidal	105	42–137 × 13–30	73 × 21	Subcuticular, pustulate, hypophyllous
Hyalopsora Aspidiotus	Lens-shaped, much flattened	25	311–496 × 86–117	432 × 102	Subepidermal, applanate, hypophyllous On second year needles
Milesia intermedia	Hemispherical to subspherical	53	84–137 × 59–84	110 × 71	Subcuticular, immersed, hypophyllous
Milesia fructuosa	Hemispherical to subspherical	393	72–180 × 40–100	123 × 71	Subcuticular, immersed
Milesia marginalis	Subspherical to almost spherical	50	129–168 × 92–134	147 × 106	Subepidermal, immersed
Milesia polypodophila	Spherical	17	175–234 × 175–243	199 × 212	Subepidermal, immersed, hypophyllous On leaves 3-8 years old
Milesia Blechni	Somewhat flask-shaped	9	110–175 × 105–150	———	Subcuticular, immersed
Milesia Kriegeriana	Hemispherical	16	98–168 × 94–168	129 × 126	Subcuticular, immersed

TABLE II, (Continued)

Species	Shape (vertical section)	No. measured	Size (breadth × height in microns) Limits	Average	Remarks
II. SUBFAMILY PUCCINIASTREAE. (Continued)					
Milesia Polypodii	Hemispherical to slightly flask-shaped	34	120–228 × 105–194	177 × 162	Subcuticular, immersed
Milesia Scolopendrii	Hemispherical to slightly flask-shaped	28	120–228 × 100–188	156 × 140	Subcuticular, immersed
Milesia vogesiaca	Hemispherical to slightly flask-shaped	34	154–241 × 168–214	201 × 195	Subcuticular, immersed
Peridermium rugosum	Spherical	11	144–223 × 144–200	170 × 169	Subepidermal, immersed, hypophyllous On second-year leaves
Uredinopsis mirabilis	Hemispherical	49	58–123 × 35–54	89 × 44	Subcuticular, immersed, hypophyllous
Uredinopsis Atkinsonii	Hemispherical, shallow	65	67–123 × 36–51	96 × 48	Subcuticular, immersed, hypophyllous
Uredinopsis Osmundae	Hemispherical, shallow	72	71–134 × 40–57	104 × 51	Subcuticular, immersed, hypophyllous
Uredinopsis Phegopteridis	Hemispherical, shallow	68	56–125 × 34–58	93 × 48	Subcuticular, immersed, hypophyllous
Uredinopsis Struthiopteridis	Hemispherical, shallow	46	71–129 × 45–58	94 × 50	Subcuticular, immersed, hypophyllous
Uredinopsis Pteridis	Hemispherical, vertically elongated	—	100–159 × 85–110	———	Subcuticular, immersed, hypophyllous On leaves of 1st or 2nd season (?)
Aecidium pseudo-columnare	Subspherical	—	160–200 × 152–180	———	Subepidermal, immersed

TABLE II. (Continued)

Species	Shape (vertical section)	No. measured	Size (breadth × height in microns) Limits	Average	Remarks
III. SUBFAMILY CRONARTIEAE					
Cronartium ribicola	Flattened hemispherical	6	1000–3500 × 34–67	———	Caulicolous, subcortical
IV. SUBFAMILY CHRYSOMYXEAE					
Chrysomyxa Ledi	Flask-shaped	29	60–128 × 45–125	105 × 82	Subepidermal, immersed
V. SUBFAMILY COLEOSPORIEAE					
Coleosporium Helianthi	Lens-shaped, elevated	12	323–458 × 92–116	361 × 103	Subepidermal, applanate
Coleosporium inconspicuum	Lens-shaped, elevated	11	226–317 × 73–85	284 × 81	Subepidermal, applanate, hypophyllous
Coleosporium Ipomoeae	Lens-shaped, elevated	—–	335–490 × 104–159	———	Subepidermal, applanate
Coleosporium delicatulum	Lens-shaped, elevated	——	354– × 110–122	———	Subepidermal, applanate
Coleosporium Laciniariae	Lens-shaped, elevated	——	323–397 × 110–122	———	Subepidermal, applanate, epiphyllous
Colesporium Solidaginis	Lens-shaped, elevated	——	244–366 × 98–104	———	Subepidermal, applanate hypophyllous
Coleosporium Terebinthinaceae	Lens-shaped, elevated	——	335–427 × 80–101	———	Subepidermal, applanate, epiphyllous
Gallowaya pinicola	Lens-shaped, elevated	7	244–427 × 48–92	———	Subepidermal, applanate

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EXPLANATION OF PLATES

PLATE 182

Fig. 1. Lateral vertical section of mature spermogonium of *Melampsora Abieti-Capraearum* from longitudinal section of leaf of *Abies balsamea*. × 700.

Fig. 2. Median vertical section of an immature spermogonium of *Melampsora Abieti-Capraearum* located under guard cell in longitudinal section of leaf of *A. balsamea*. × 480. Note the branched spermatiophores.

Fig. 3. Median vertical section of an immature spermogonium of *Melampsora Abieti Capraearum*, approximately 2/3 mature size, from transverse section of leaf of *A. balsamea*. × 212. Dark areas within spermogonium are remains of mesophyll cells.

Fig. 4. Median vertical section of the mature spermogonium of *Caeoma Faulliana* from a transverse section of leaf of *Abies lasiocarpa*. × 135.

Fig. 5. Median vertical section of mature spermogonium of *Melampsoridium betulinum* from transverse section of leaf of *Larix decidua*. × 280.

Fig. 6. Median vertical section of mature spermogonium of *Melampsora Abietis-canadensis* from cone scale of *Tsuga canadensis*. × 325.

Fig. 7. Median vertical section of mature spermogonium of *Melampsora Bigelowii* from longitudinal section of leaf of *Larix laricina*. × 280. Note mass of spermatia above spermogonium.

Fig. 8. Median vertical section of immature spermogonium of *Melampsora Larici Capraearum* from transverse section of leaf of *Larix laricina*. × 330. Note unbroken elevated cuticle.

Fig. 9. Median vertical section of mature spermogonia of *Melampsora Larici-Capraearum* from transverse section of leaf of *Larix decidua*. × 280.

PLATE 183

Fig. 10. Median vertical section of a mature spermogonium of *Melampsorella Cerastii* from longitudinal section of leaf of *A. balsamea*. × 560. Note cuticle ruptured at right overlying spermogonium.

Fig. 11. Median vertical section of immature spermogonium of *Calyptospora Goeppertiana* from transverse section of leaf of *A. balsamea*. × 413.

Fig. 12. Median vertical section of mature spermogonium of *Pucciniastrum arcticum* from transverse section of leaf of *Picea glauca*. × 280.

Fig. 13. Median vertical section of mature spermogonium of *Pucciniastrum arcticum* from transverse section of leaf of *Picea glauca*. × 625. Note cells in stroma from which spermatiophores branch.

Fig. 14. Median vertical section of spermogonium of *Thecopsora Myrtilli* from transverse section of leaf of *Tsuga canadensis*. × 280.

Fig. 15. Transverse section of leaf of *A. balsamea* infected with *Hyalopsora Aspidiotus*. Note abundance of mycelium in intercellular spaces, spermogonia and spermatia strewn over leaf surface. × 90.

PLATE 184

Fig. 16. Median vertical section of spermogonium of *Hyalopsora Aspidiotus* at very early stage in development, from longitudinal section of leaf of *A. balsamea.* × 290.

Fig. 17. Median vertical section of immature spermogonium of *Milesia intermedia* from transverse section of leaf of *A. balsamea.* × 288. Note depressed epidermal cells, spermatiophores and spermatia and overlying unruptured cuticle, with intermediate layer, darkly stained, beneath.

Fig. 18. Median vertical section of immature spermogonium of *Milesia intermedia* from transverse section of leaf of *A. balsamea.* × 888. Note depressed epidermal cells, separated spermatiophores, spermatia and cuticle minus intermediate layer in centre above spermogonium.

Fig. 19. Median vertical section of very early stage in the development of the spermogonium of *Milesia marginalis* from transverse section of leaf of *A. balsamea.* × 550. Note central cell in epidermis has been invaded.

Fig. 20. Median vertical section of early stage in the development of the spermogonium of *Milesia marginalis* from longitudinal section of *A. balsamea.* × 666. Note depressed mesophyll cells, spermatiophores and central epidermal cell invaded by enlarged hyphae.

PLATE 185

Fig. 21. Median vertical section of young spermogonium — a later stage than that shown in Fig. 23 — of *Milesia marginalis* from transverse section of leaf of *A. balsamea.* × 374. Note epidermal cells have disappeared.

Fig. 22. Median vertical section of spermogonium of *Milesia marginalis,* epidermal cells over left, from transverse section of leaf of *A. balsamea.* × 280.

Fig. 23. Median vertical section of mature spermogonium of *Milesia marginalis* from transverse section of leaf of *A. balsamea.* × 280. Note teeth from outer epidermal wall projecting into spermogonium.

Fig. 24. Median vertical section of mature spermogonium of *Milesia polypodophila* from transverse section of leaf of *A. balsamea.* × 280. Note two "flexuous hyphae."

Fig. 25. Median vertical section of an immature spermogonium of *Milesia Polypodii,* showing an early stage of development, from transverse section of leaf of *Abies concolor.* × 280. Note epidermal cells below.

Fig. 26. Median vertical section of mature spermogonium of *Milesia polypodophila* from transverse section of leaf of *A. balsamea.* × 280. Note shortened spermatiophores and chains of spermatia.

Fig. 27. *Milesia Scolopendrii,* "flexuous hypha" with spermatia attached. × 1000. This is a higher magnification of Fig. 28.

PLATE 186

Figs. 28 and 29. Photographs of median vertical section of mature spermogonium of *Milesia Scolopendrii* from transverse section of mature leaf of *A. concolor* from hand section, each taken at a different focus. Note flexuous hyphae with spermatia attached.

Fig. 30. Median vertical section of mature spermogonium of *Milesia Blechni* from transverse section of leaf of *Abies alba*. × 300.
Fig. 31. Median vertical section of mature spermogonium of *Milesia Kriegeriana* from transverse section of leaf of *A. alba*. × 300.
Fig. 32. Median vertical section of immature spermogonium of *Milesia Polypodii*, 2/3 mature size, from transverse section of leaf of *A. concolor*. × 372. Note short spermatiophores and central core of long hyphae.
Fig. 33. Mature spermogonium of *Milesia Polypodii* from transverse section of leaf of *A. alba*. × 280. Note "flexuous hyphae" in central cavity.

PLATE 187

Fig. 34. Median vertical section of mature spermogonium of *Milesia vogesiaca*, from transverse section of leaf of *A. alba*. × 300.
Fig. 35. Median vertical section of immature spermogonium of *Uredinopsis mirabilis*, from transverse section of leaf of *A. balsamea*. × 446.
Fig. 36. Median vertical section of mature spermogonium of *Uredinopsis Atkinsonii*, from transverse section of leaf of *A. balsamea* to show branching of spermatiophores from stroma. × 420.
Fig. 37. Median vertical section of mature spermogonium of *Chrysomyxa Ledi*, from transverse section of leaf of *Picea mariana*. × 350.

PLATE 188

Fig. 38. Median vertical section of mature spermogonium of *Cronartium ribicola* from stem of *Pinus Strobus*. × 170.
Fig. 39. Median vertical section of mature spermogonium of *Coleosporium Helianthi*, from transverse section of leaf of *Pinus virginiana*. × 170.
Fig. 40. Median vertical section of immature spermogonium of *Coleosporium inconspicuum*, from longitudinal section of leaf of *P. virginiana*. × 170.
Fig. 41. Median vertical section of spermogonium of *Gallowaya pinicola* from transverse section of leaf of *P. virginiana*. × 142.

LABORATORY OF PLANT PATHOLOGY,
ARNOLD ARBORETUM, HARVARD UNIVERSITY.

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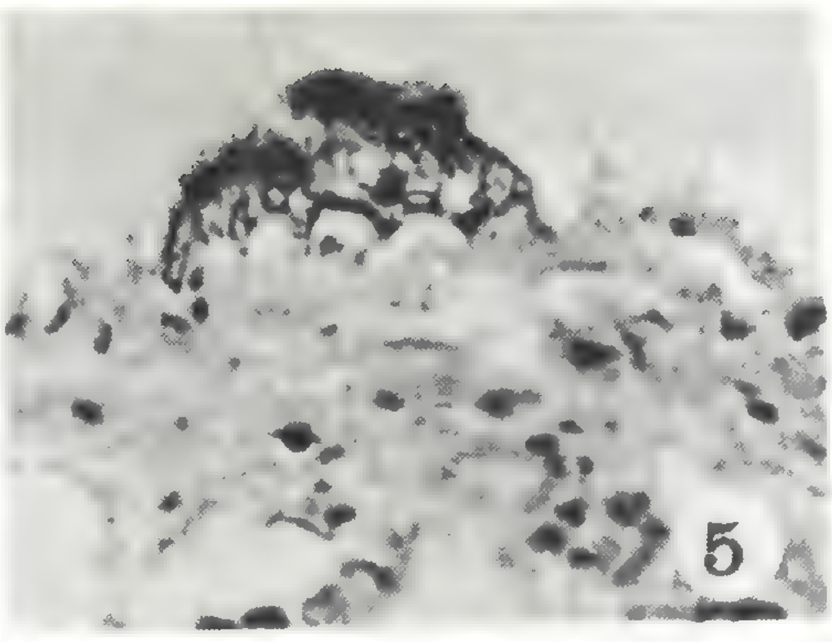
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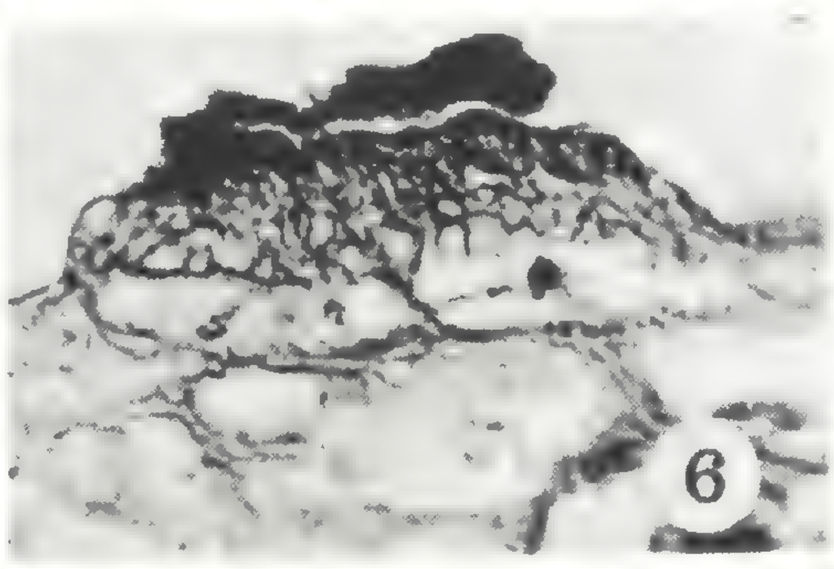
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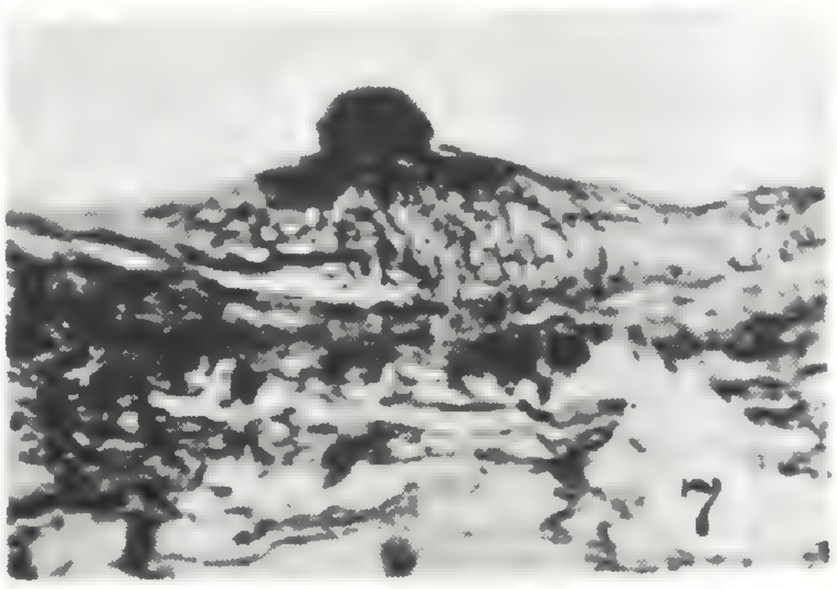
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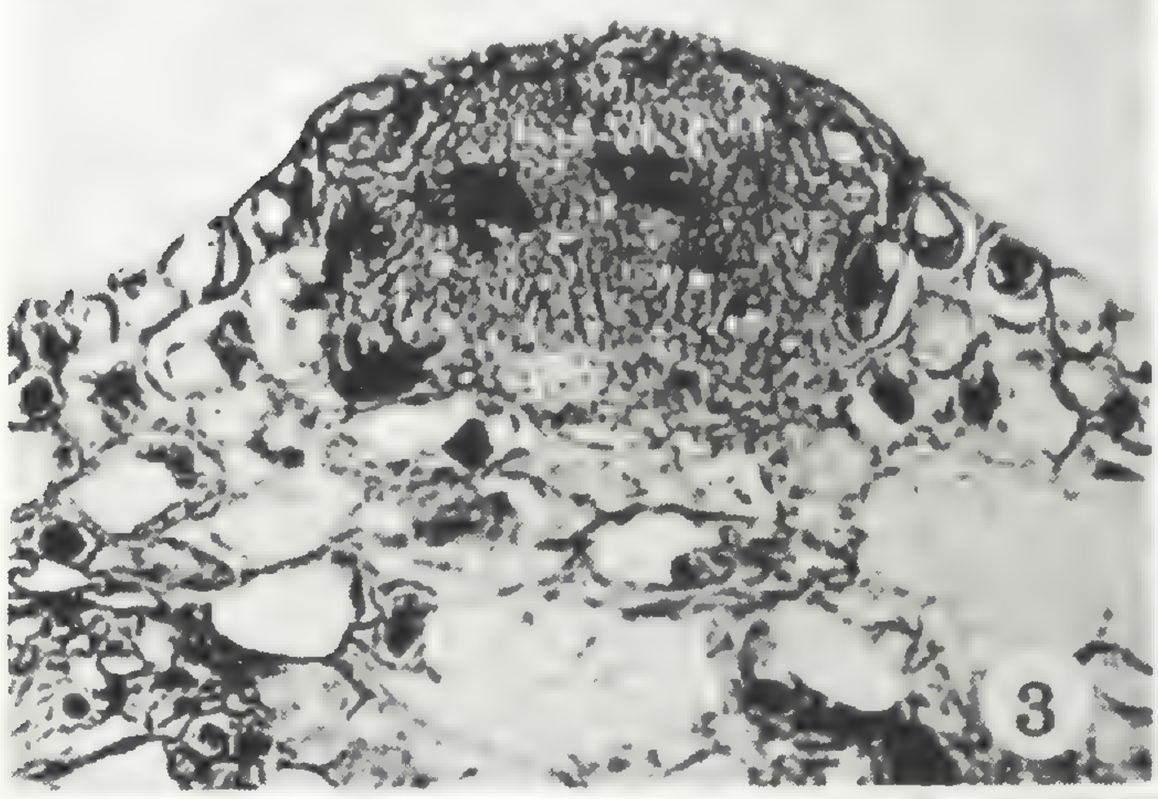
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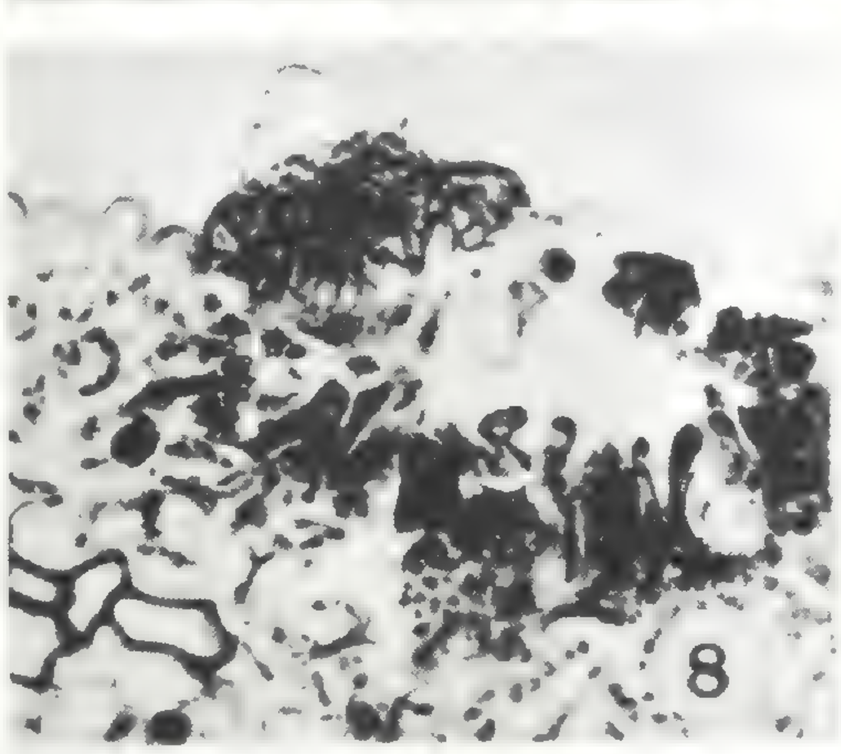
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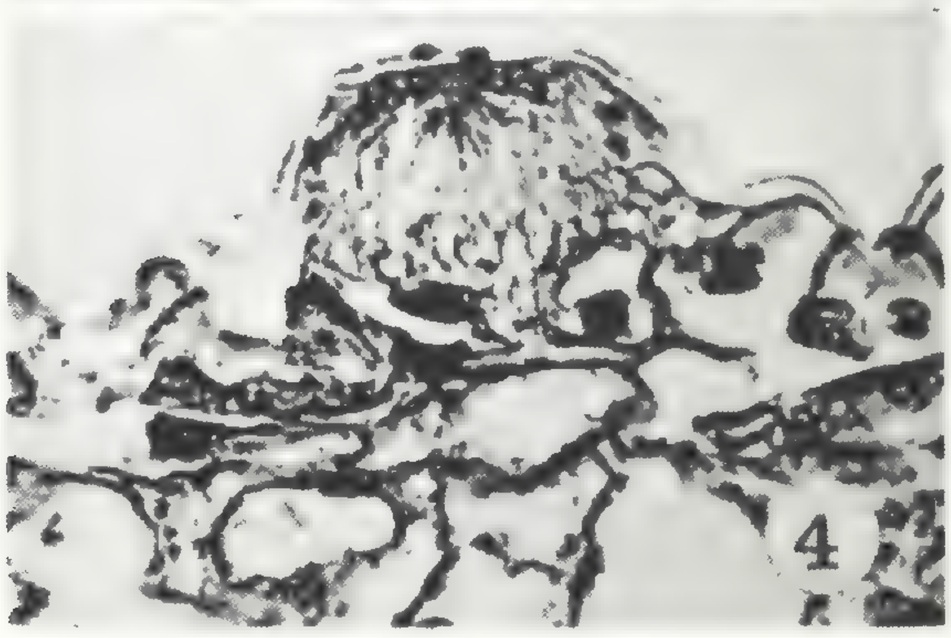
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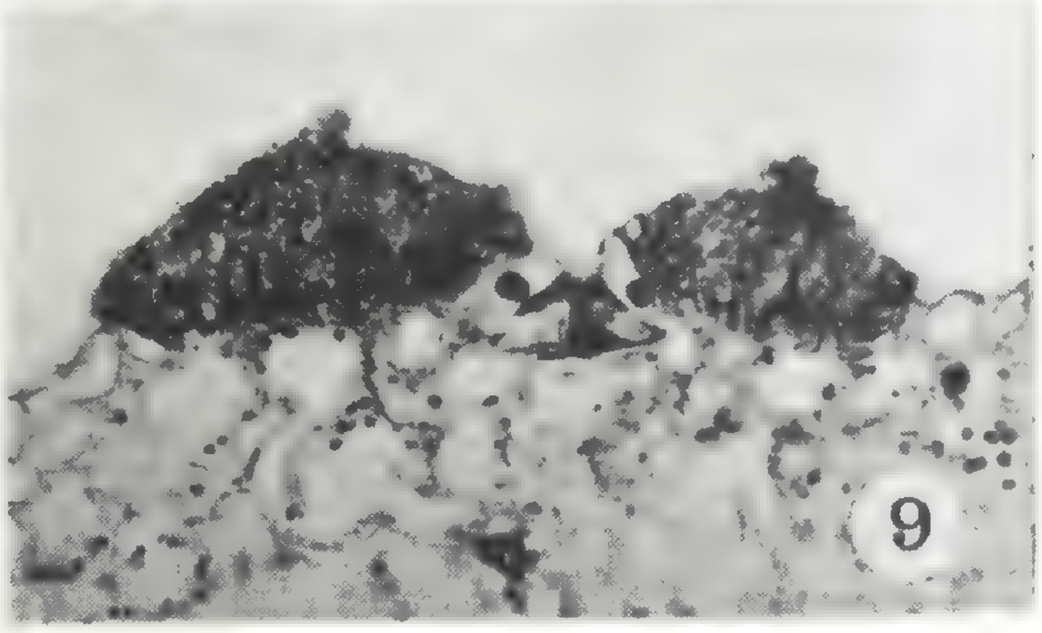
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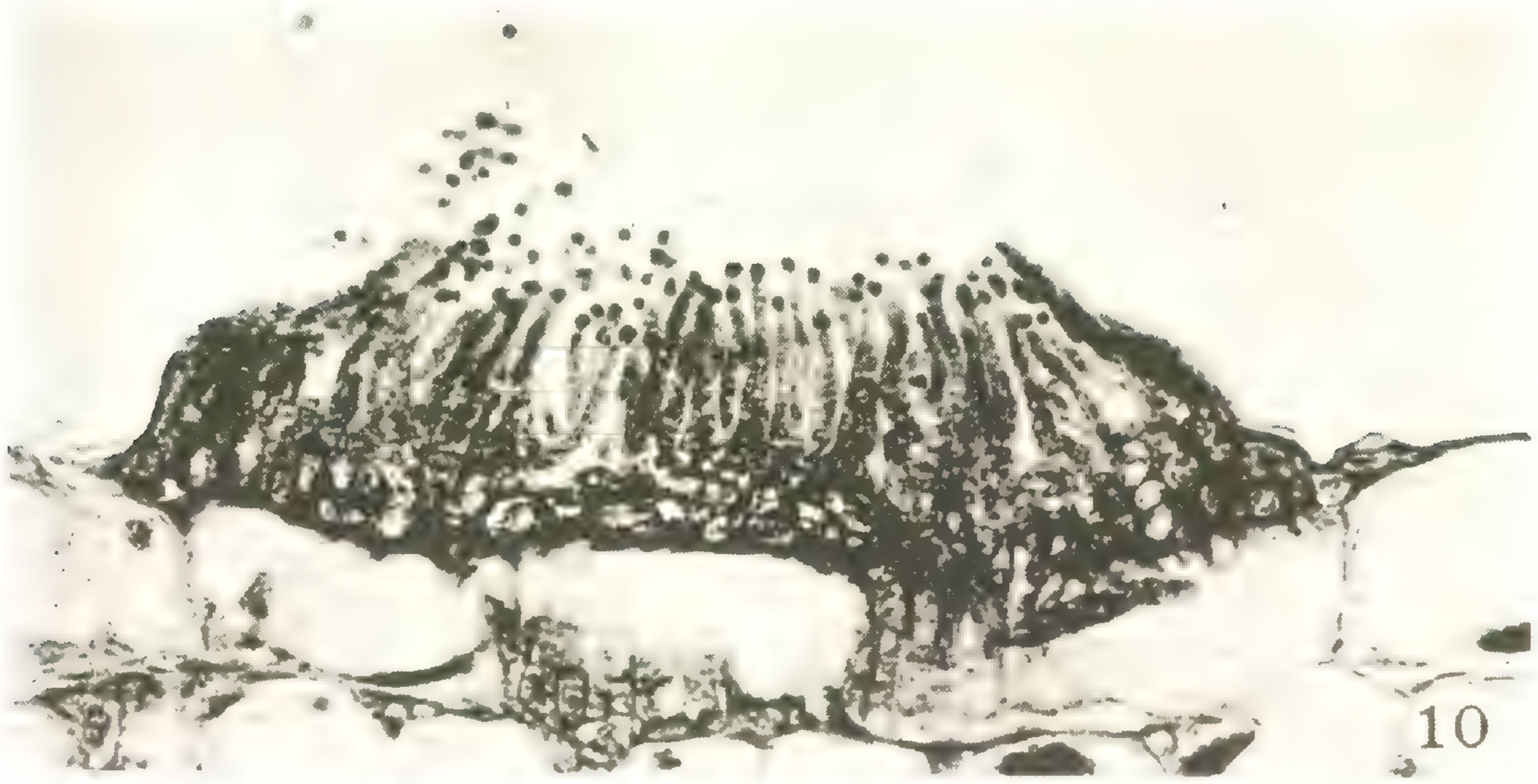
SPERMOGONIA OF THE MELAMPSORACEAE

FULL-TONE — MERIDEN



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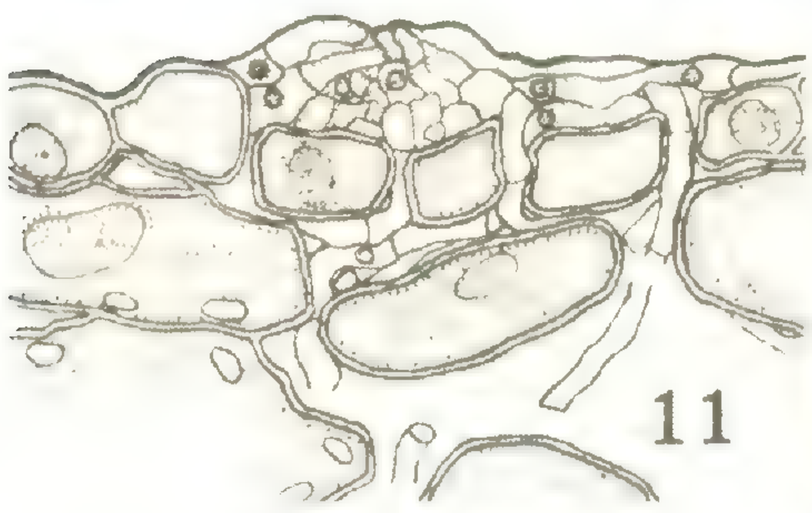

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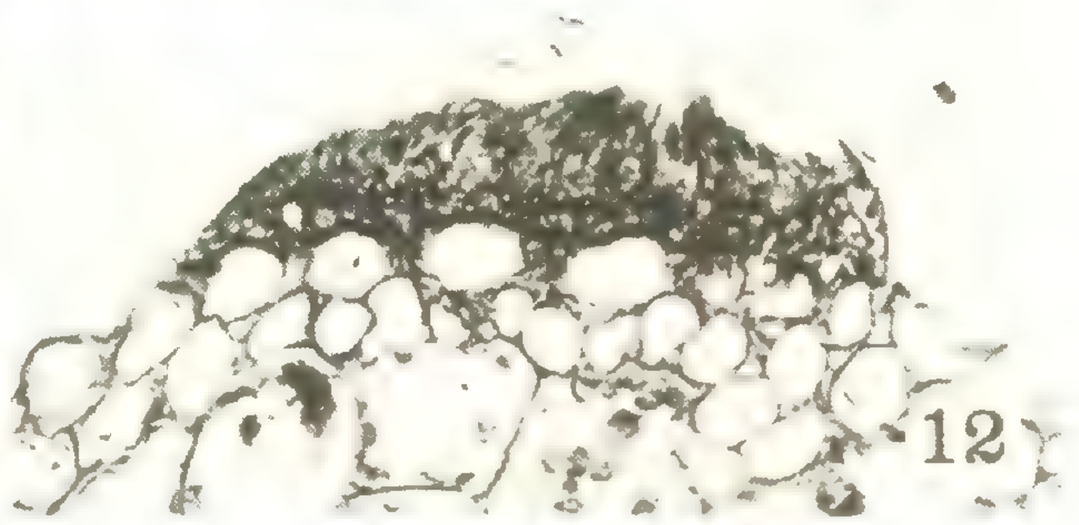

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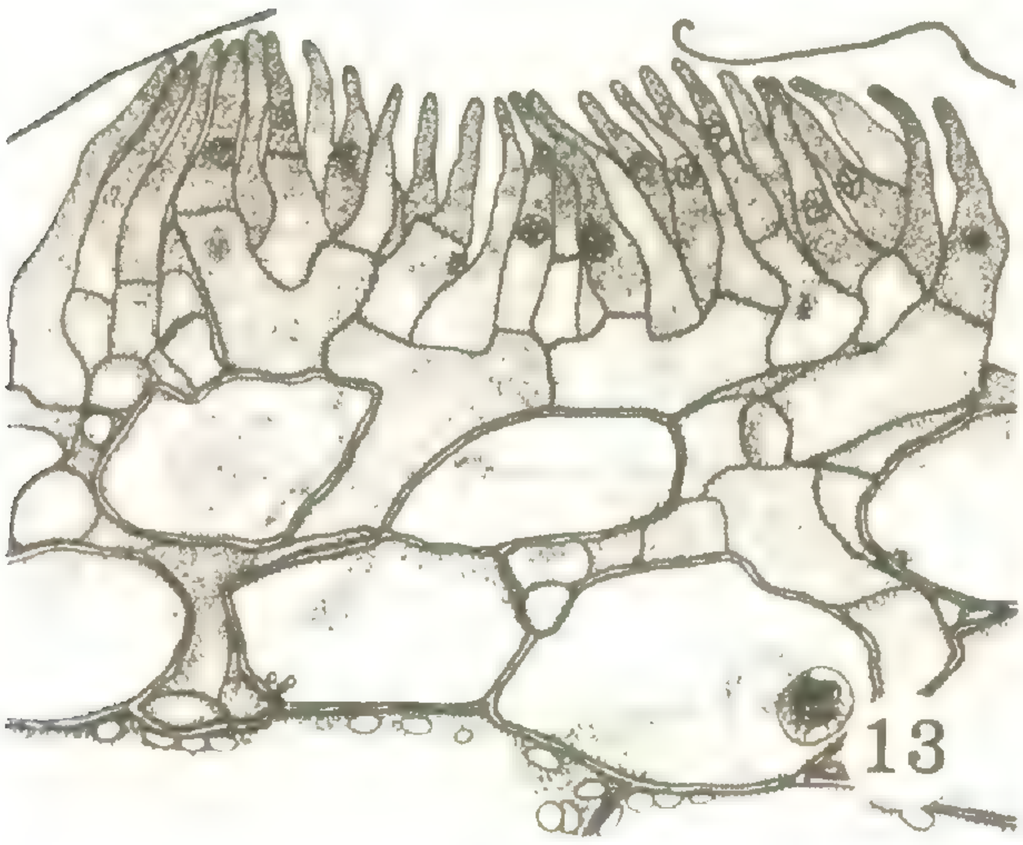

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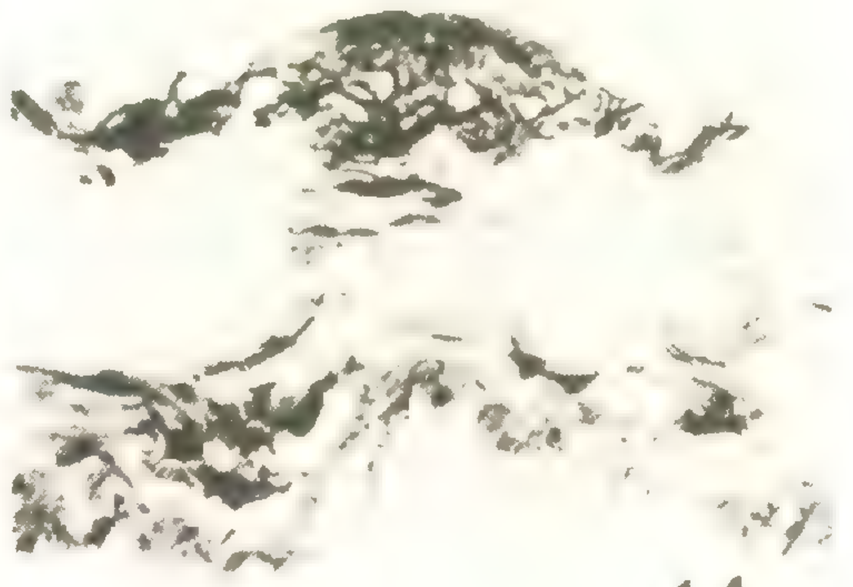

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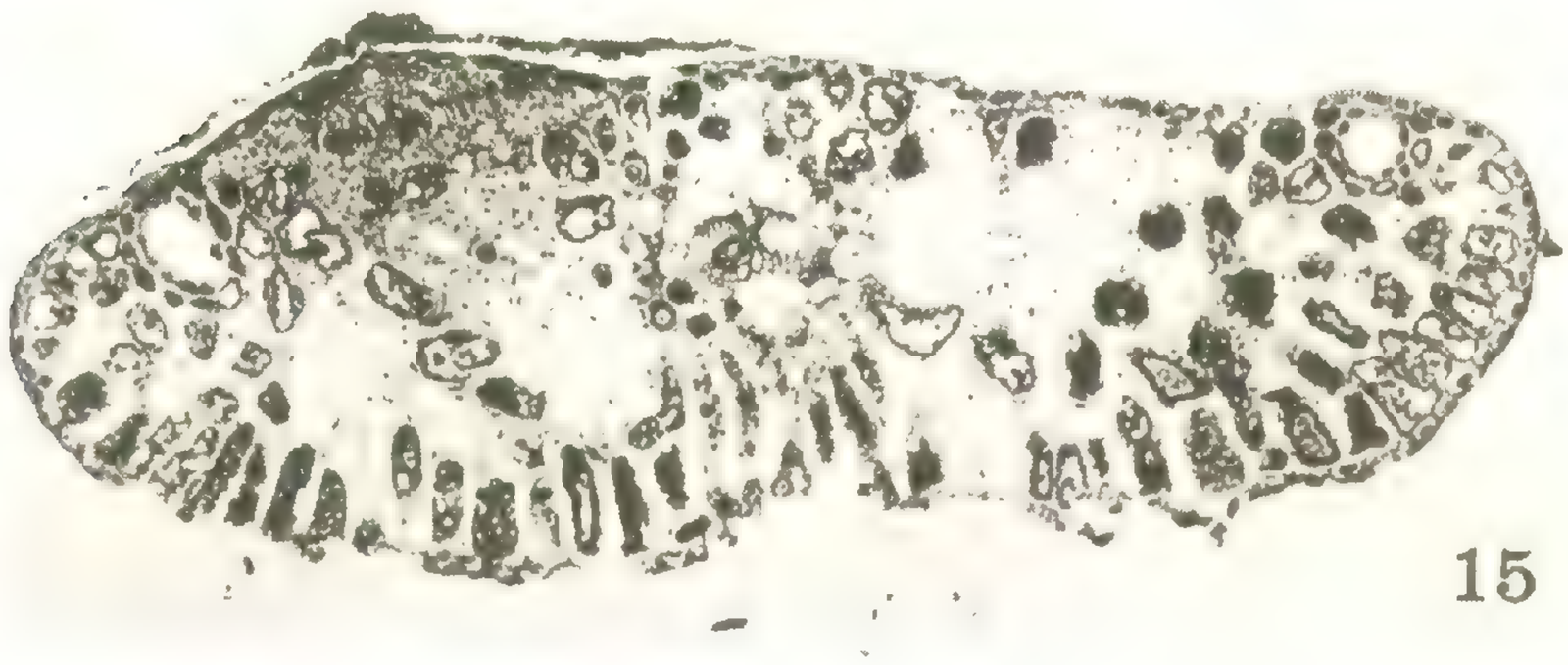

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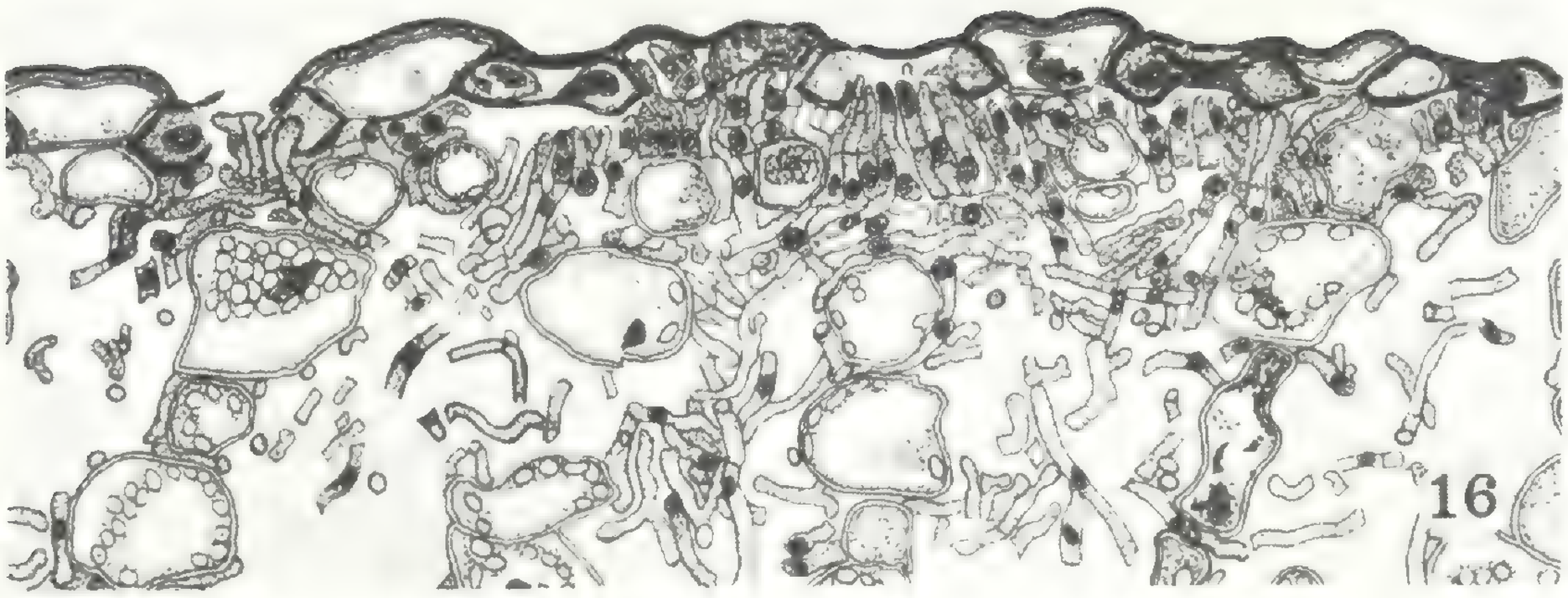
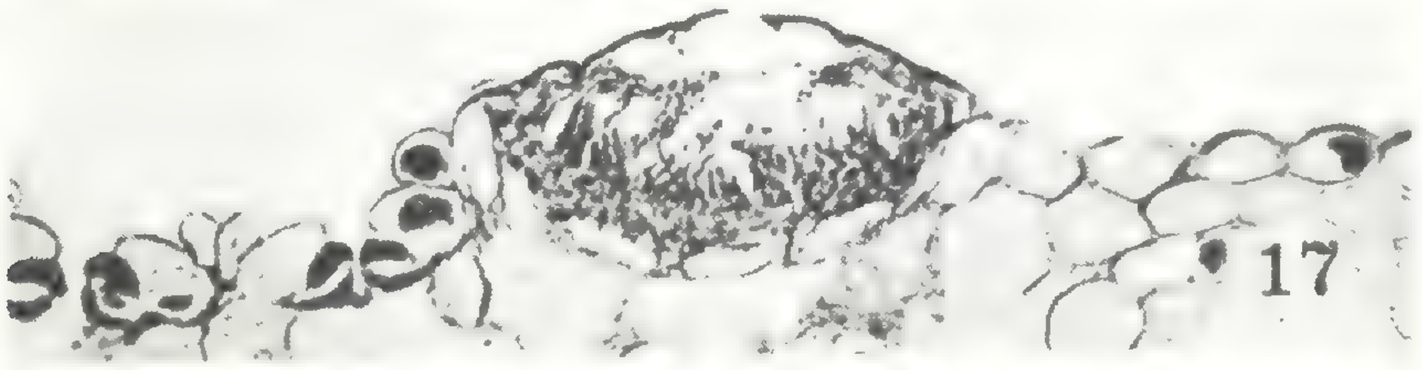
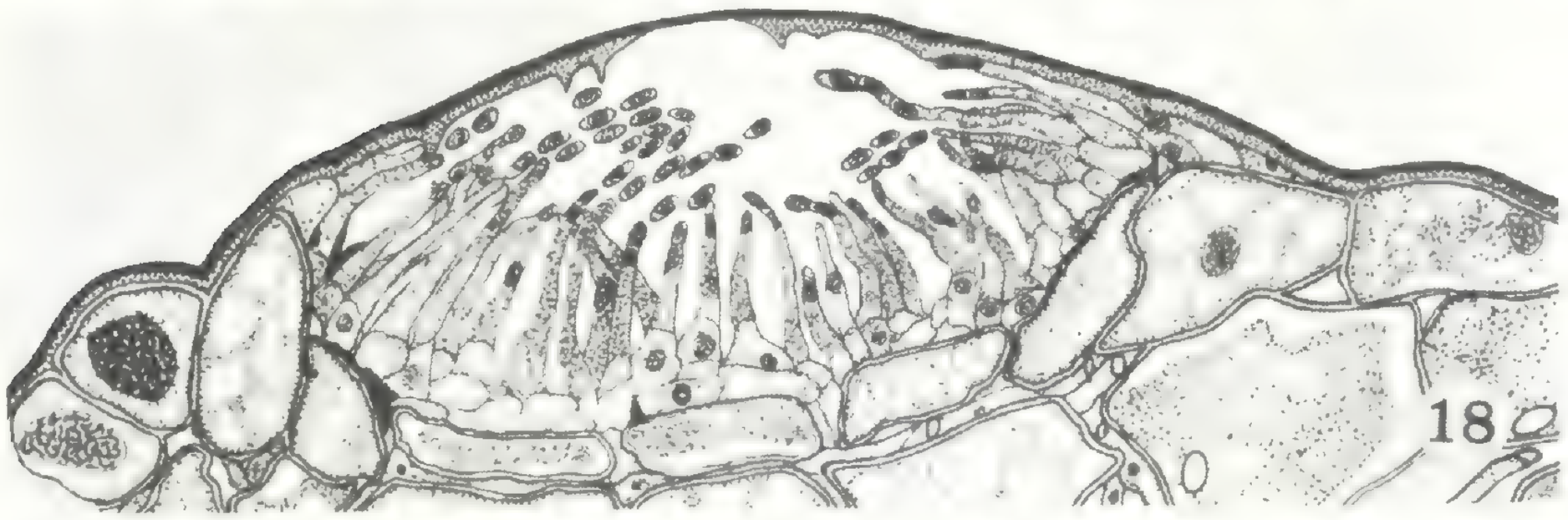
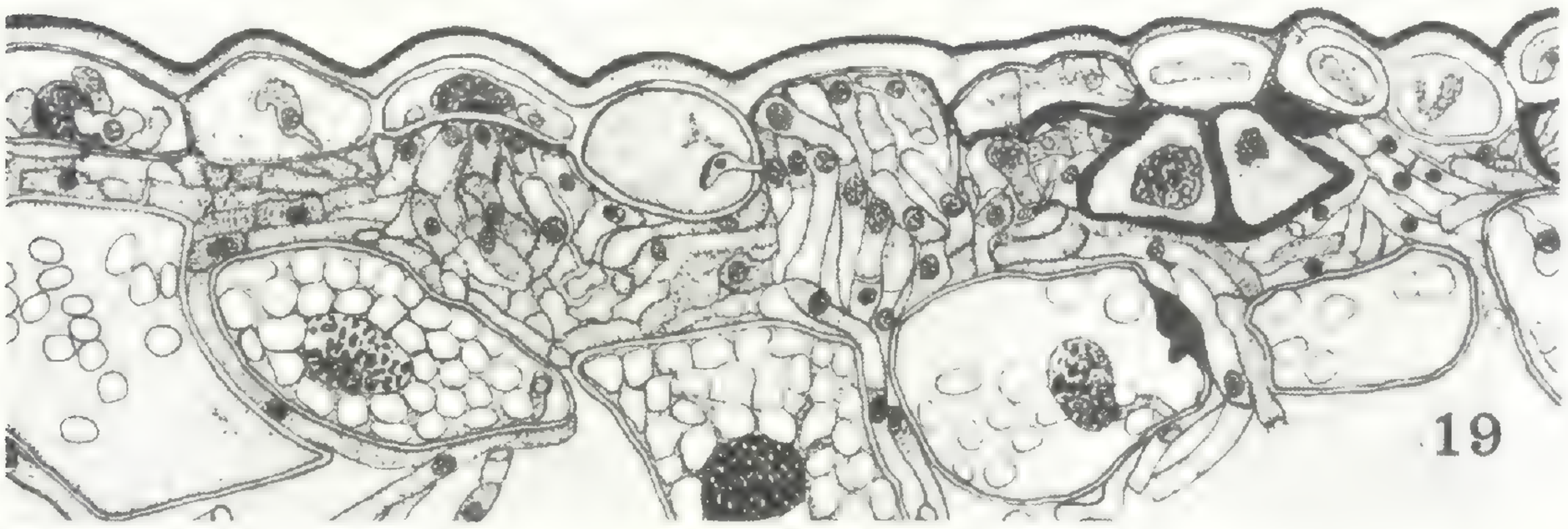
SPERMOGONIA OF THE MELAMPSORACEAE

FULL TONE — MERIDEN



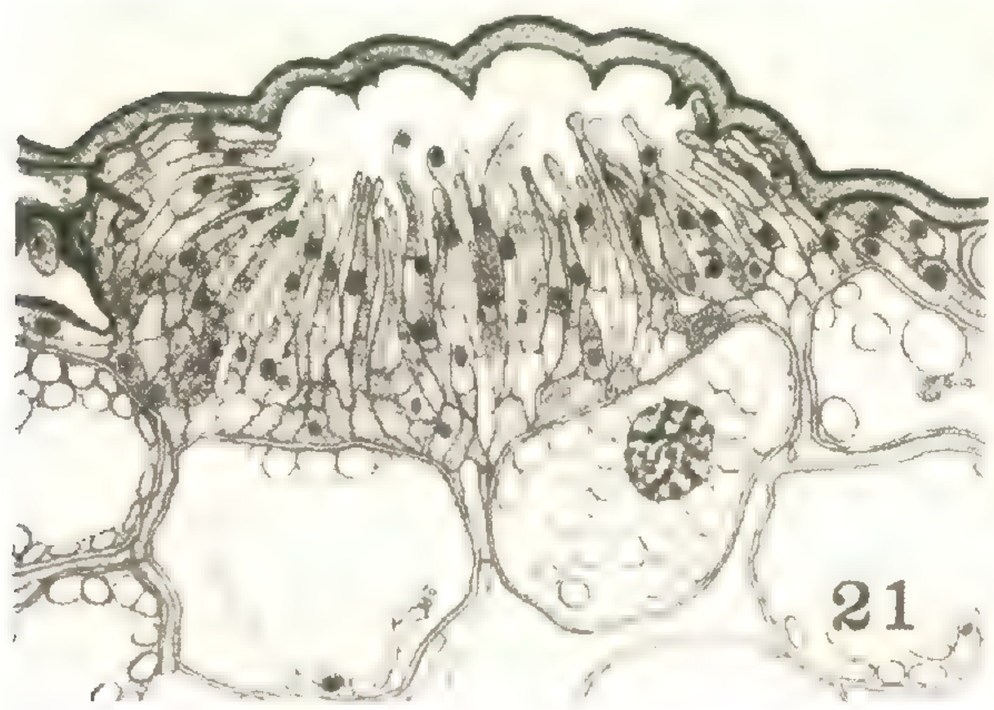


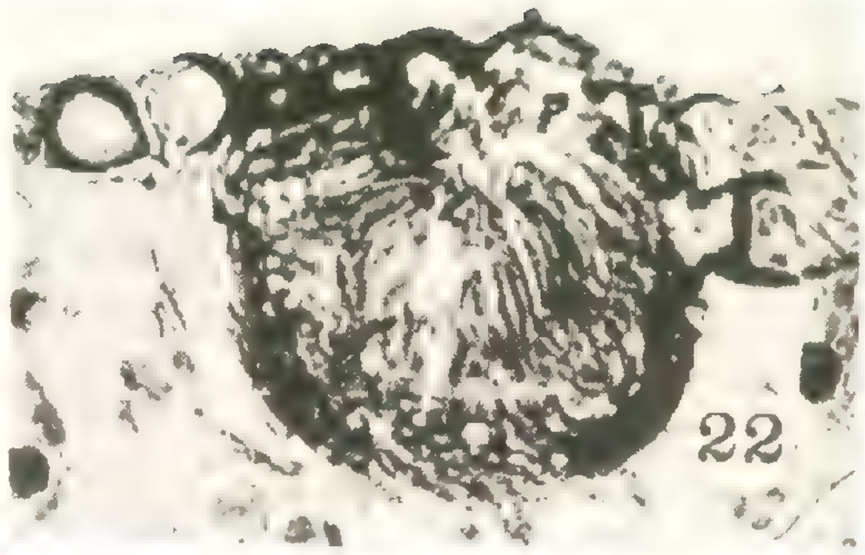


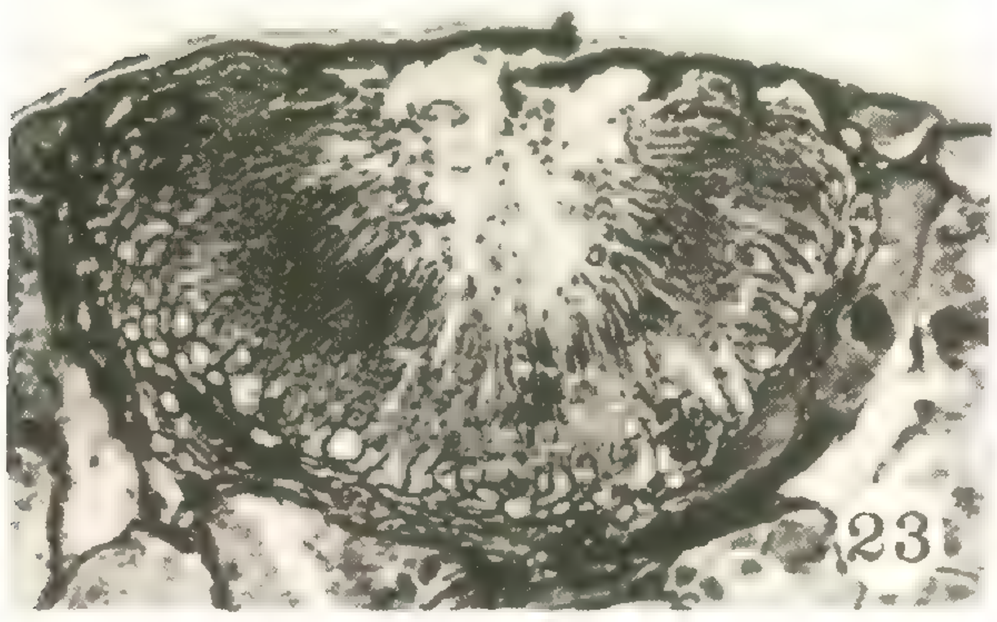


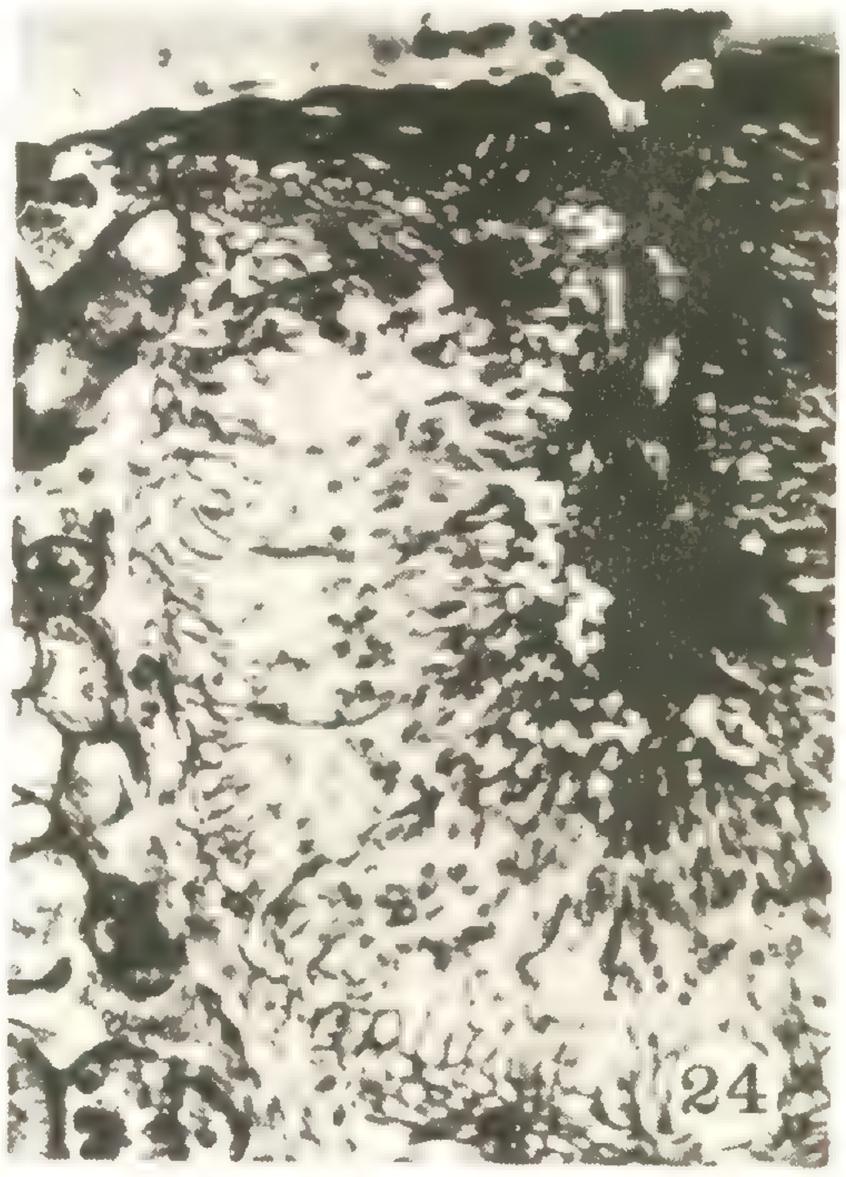
SPERMOGONIA OF THE MELAMPSORACEAE

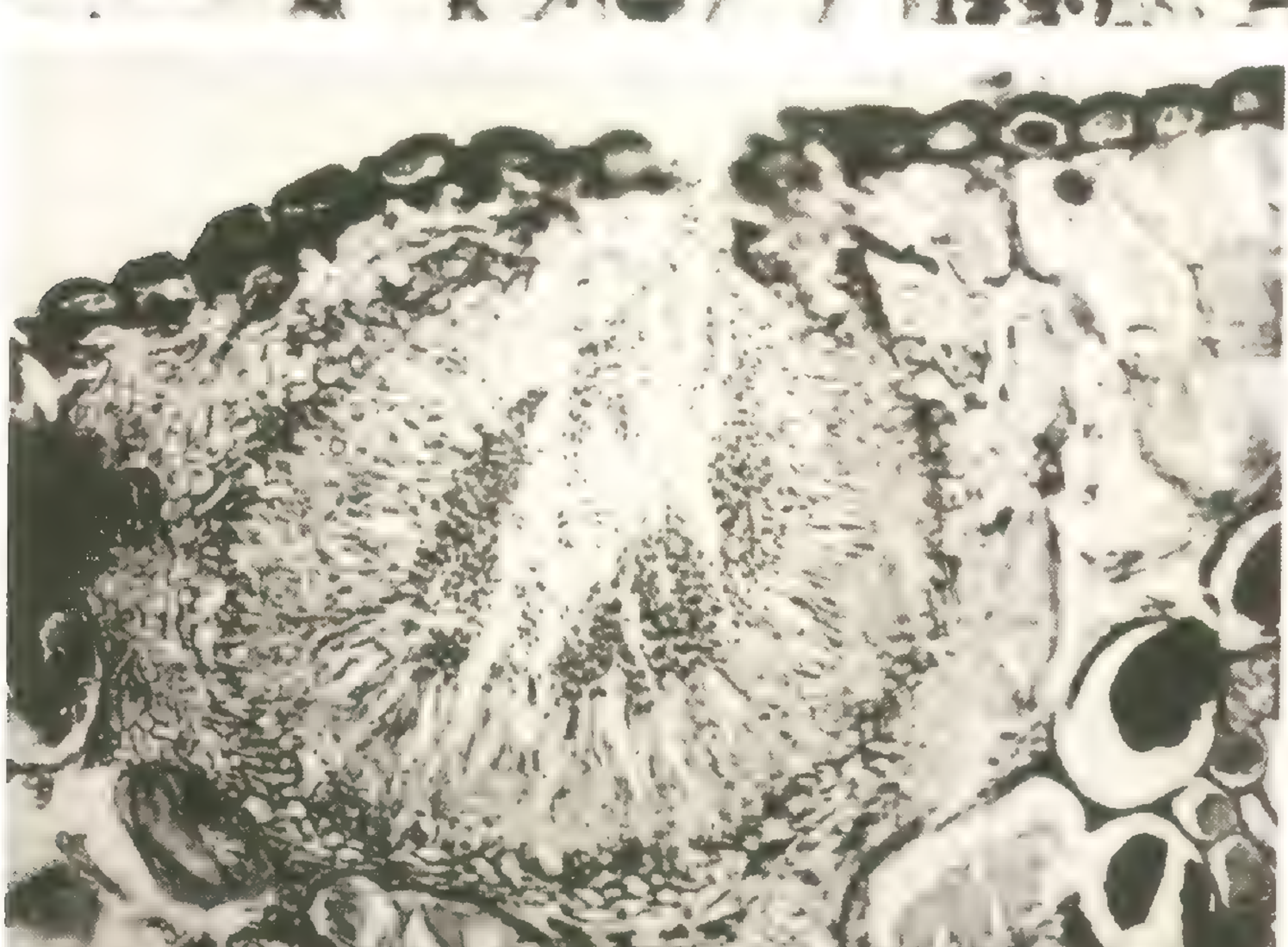
FULL-TONE — MERIDEN





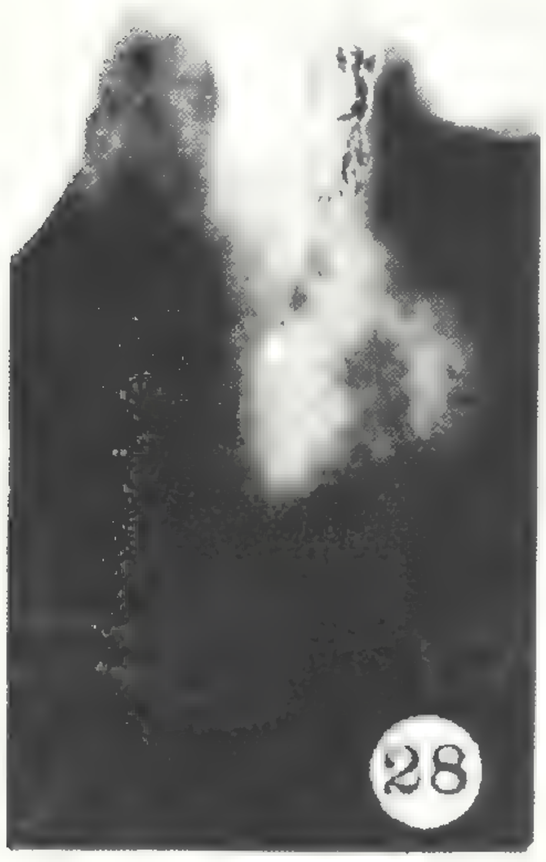


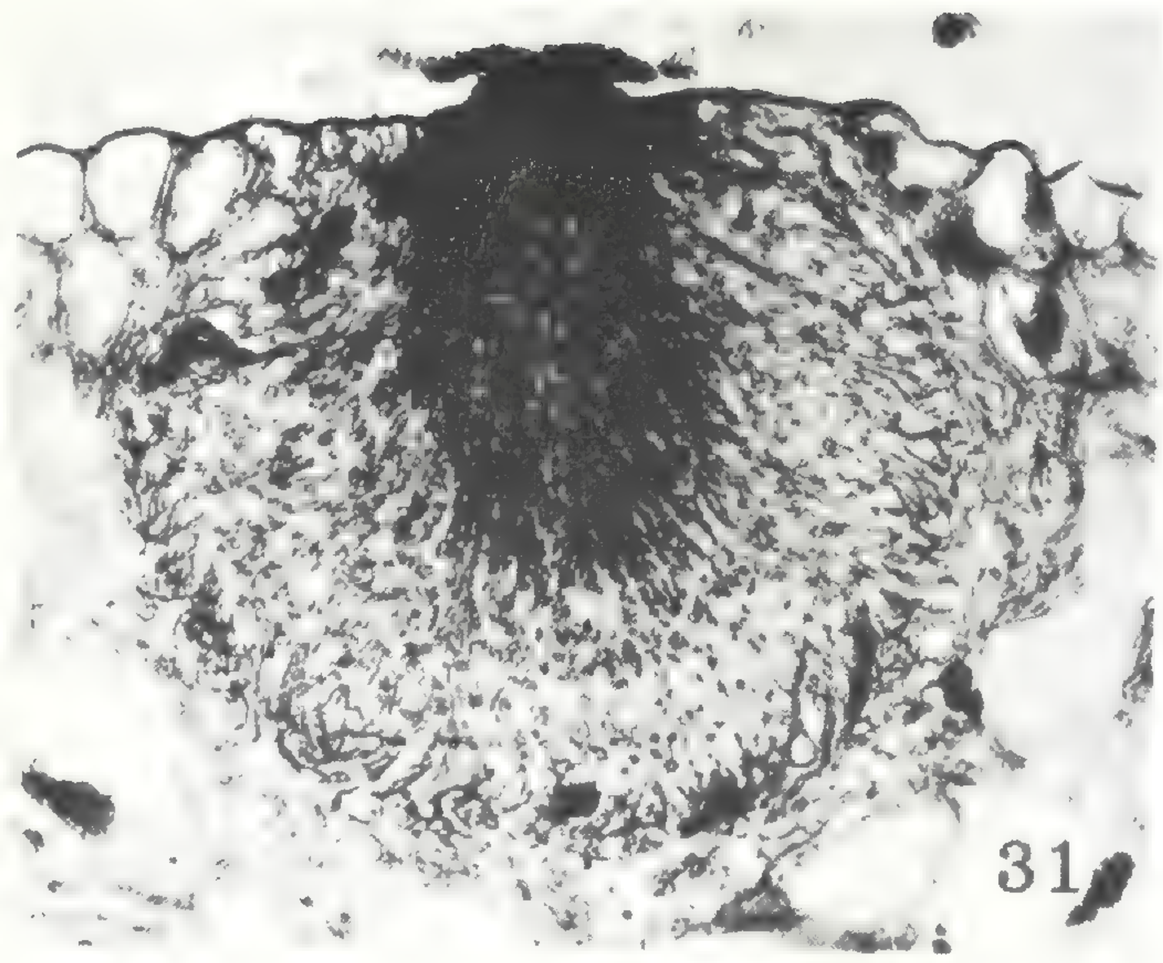


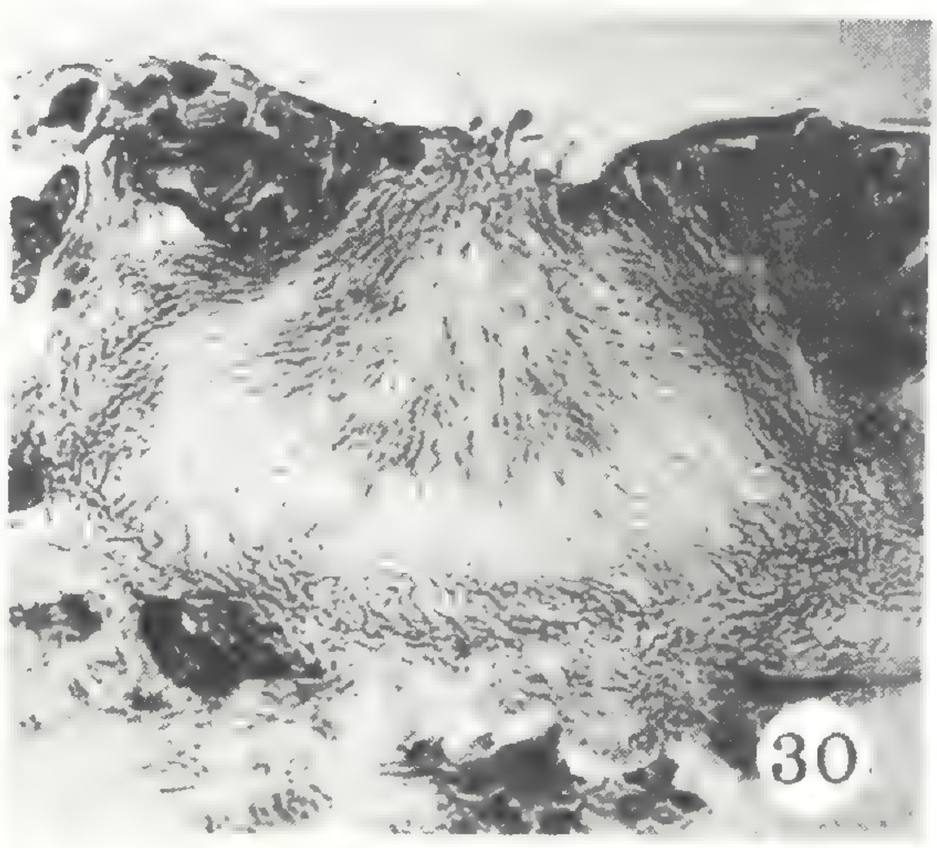


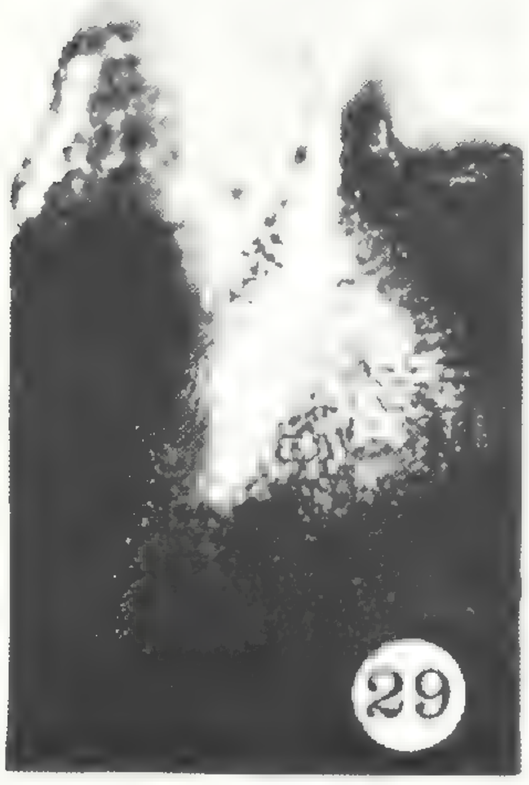
SPERMOGONIA OF THE MELAMPSORACEAE

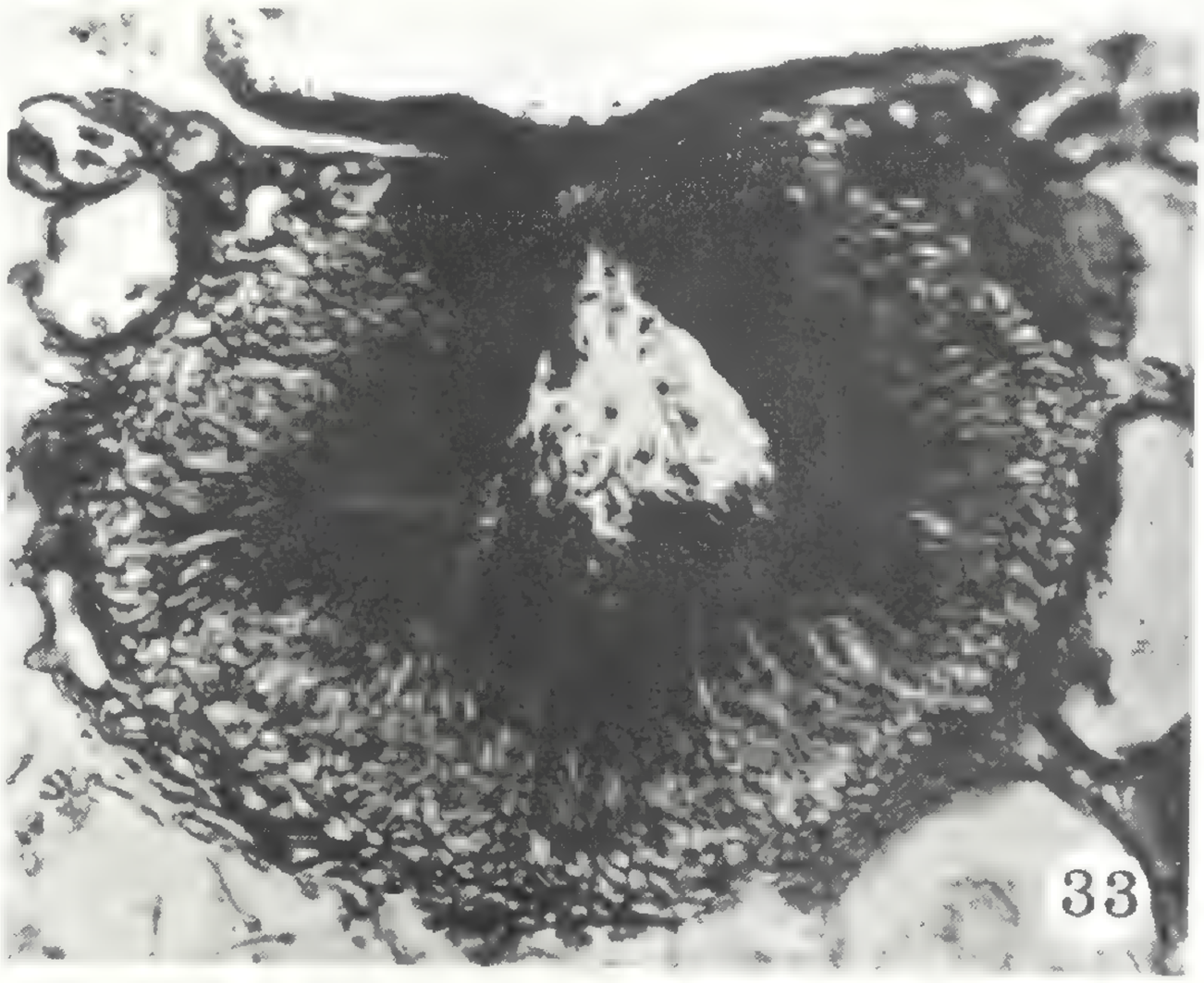
FULL-TONE — MERIDEN





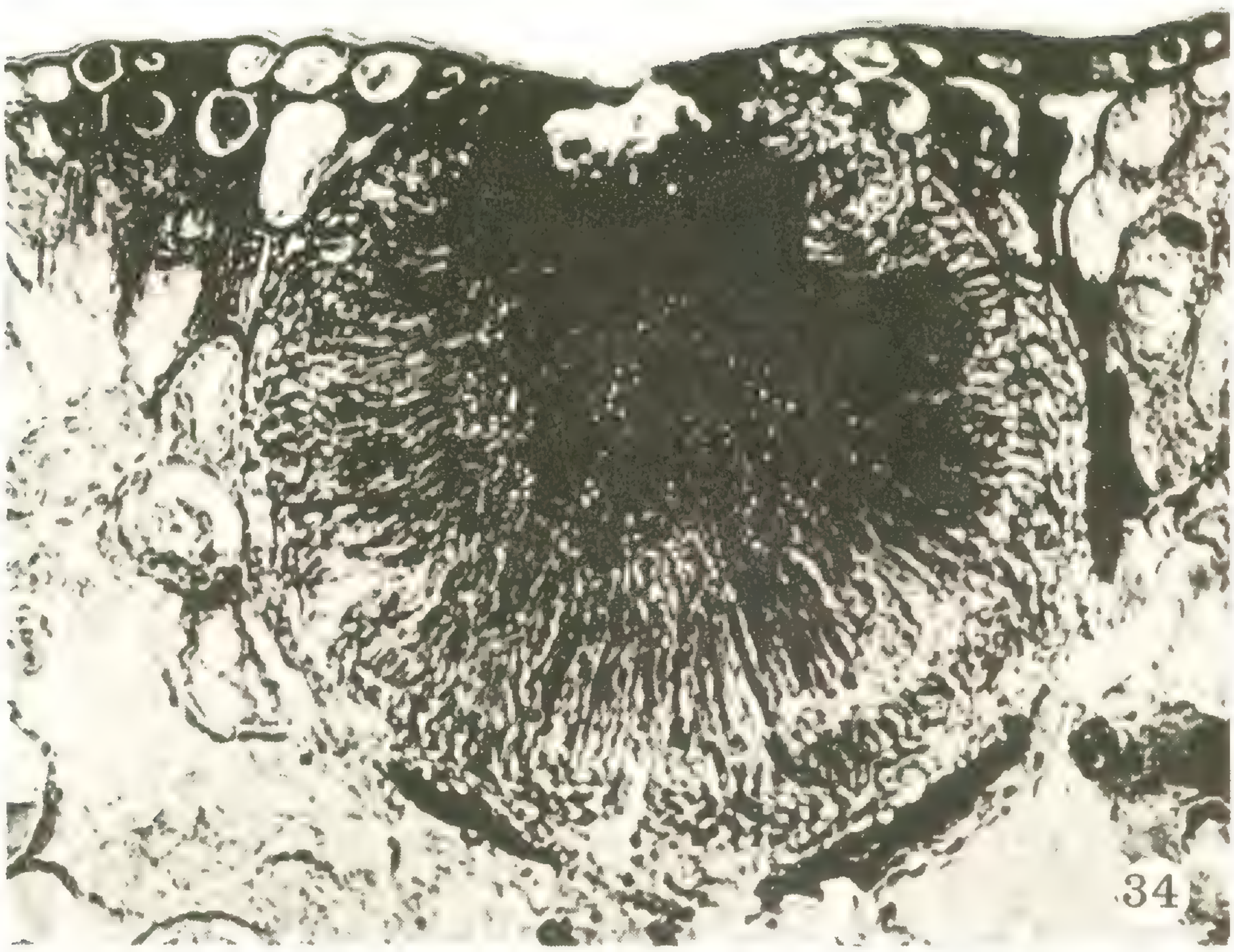






SPERMOGONIA OF THE MELAMPSORACEAE

FULL-TONE — MERIDEN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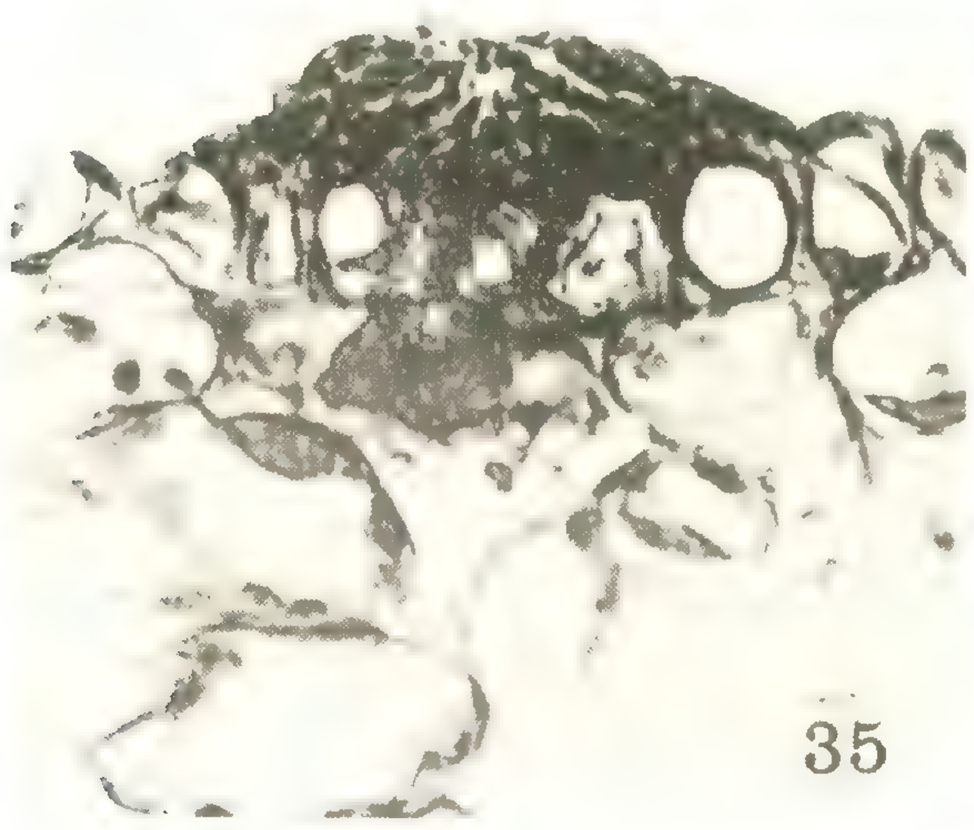
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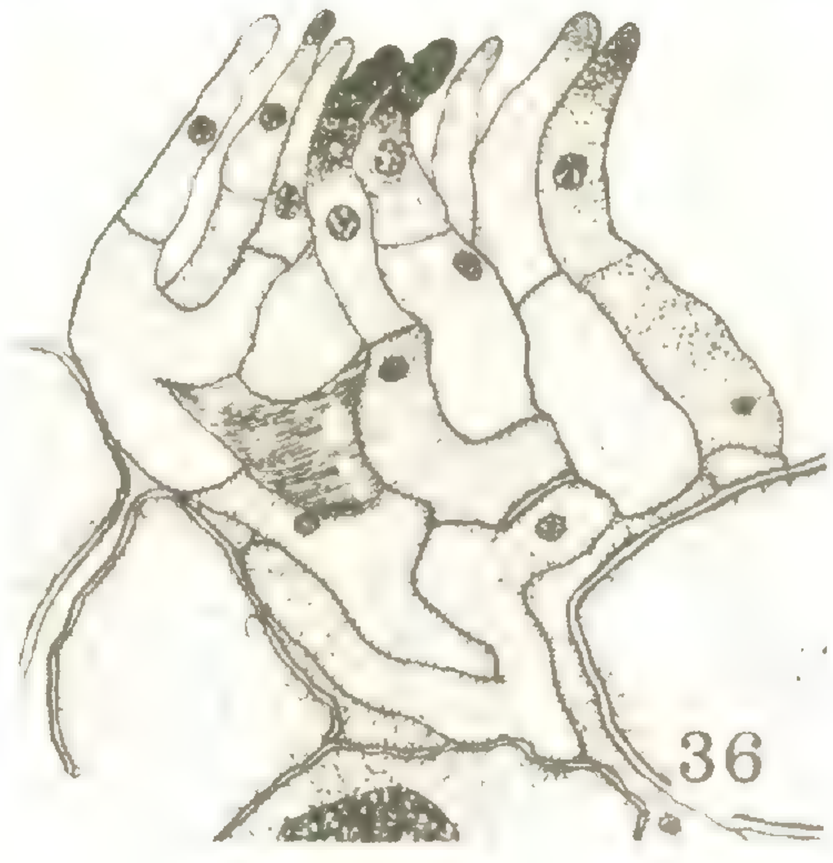
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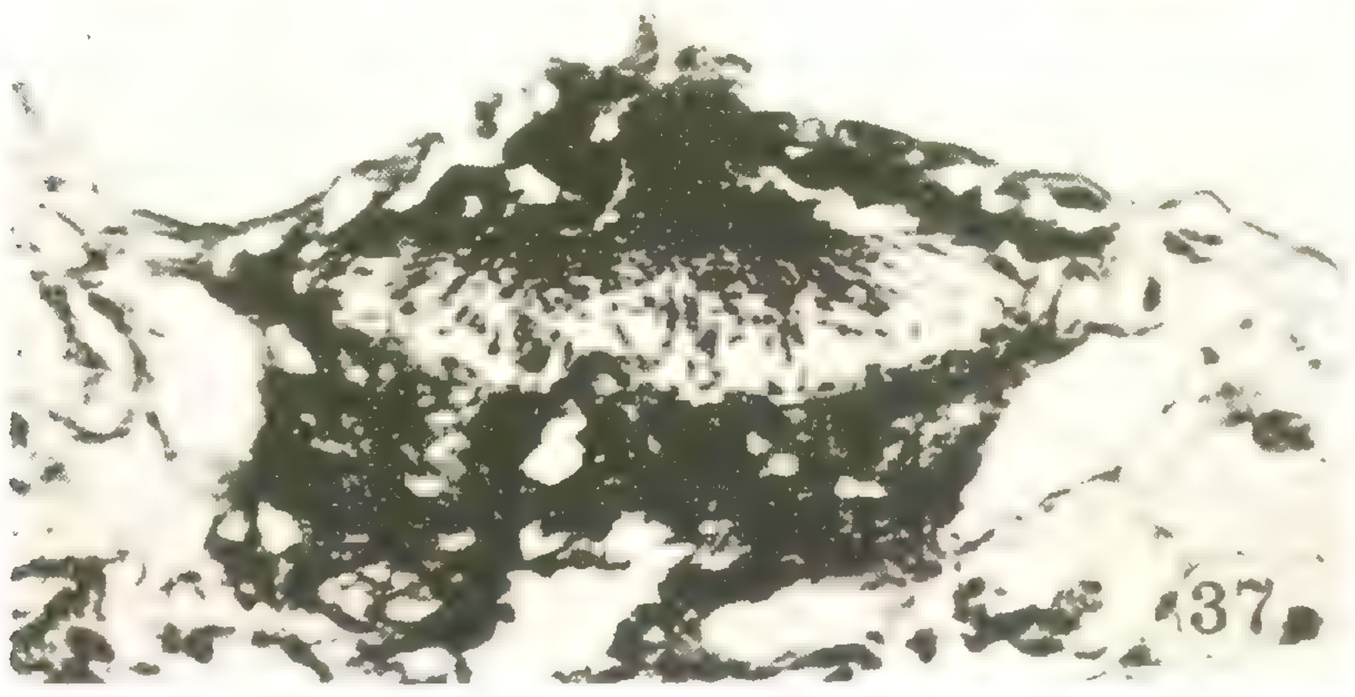
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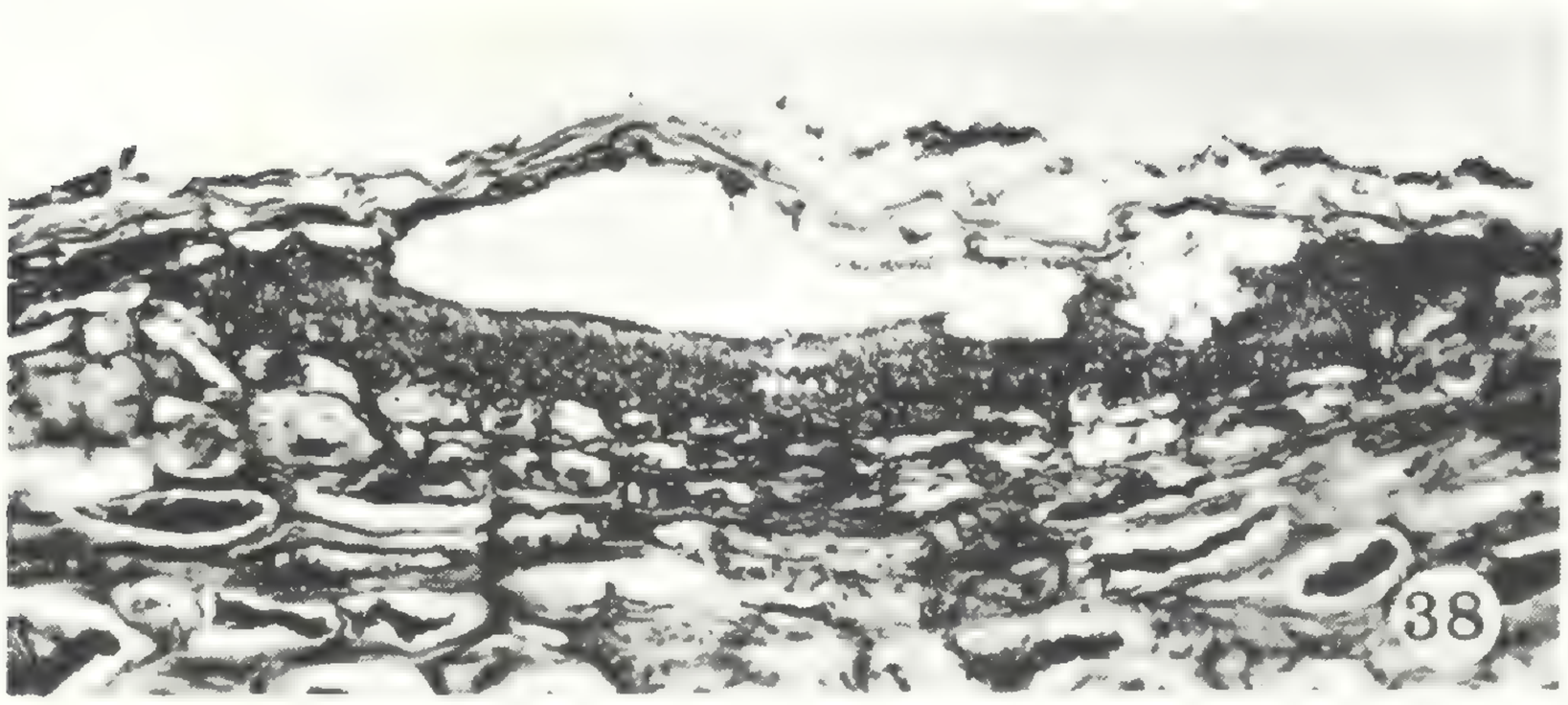
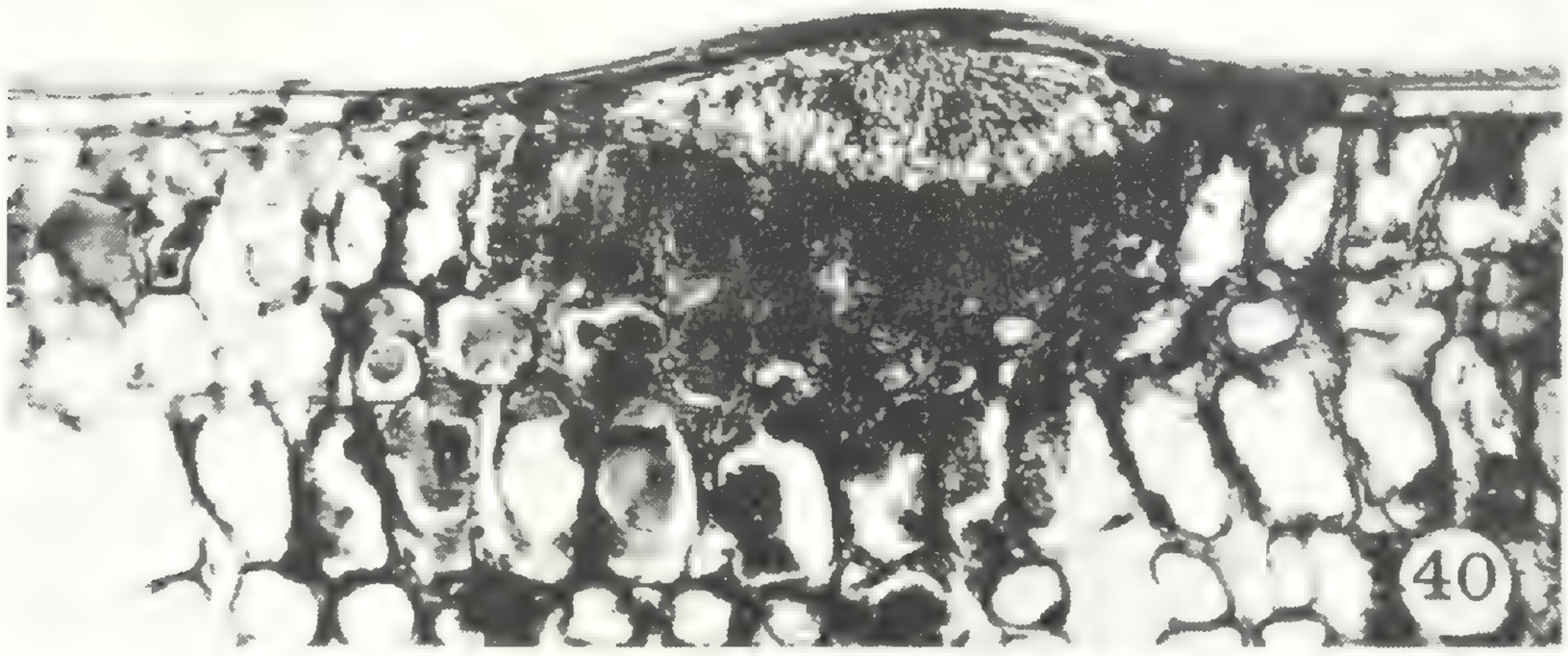
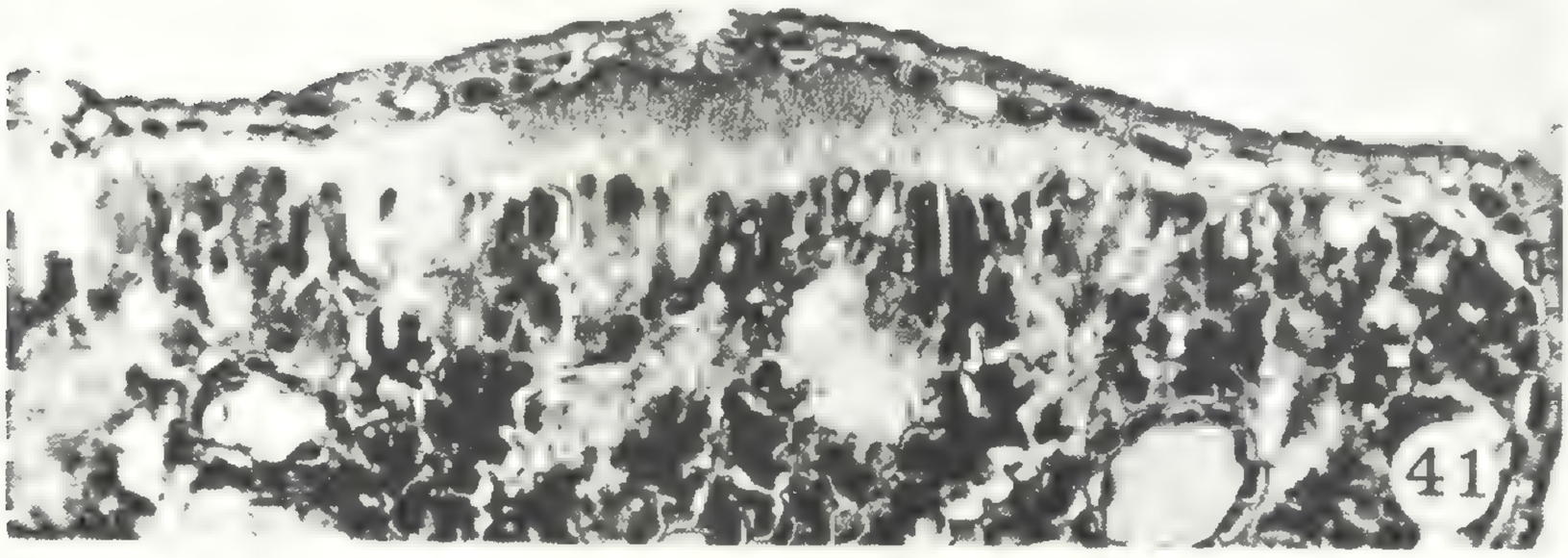
SPERMOGONIA OF THE MELAMPSORACEAE

FULL-TONE — MERIDEN







SPERMOGONIA OF THE MELAMPSORACEAE

FULL-TONE — MERIDEN

THE EXPERIMENTAL PRODUCTION OF POLYPLOIDY

KARL SAX

With plate 189

POLYPLOIDY has played an important rôle in the evolution of the angiosperms, and it is estimated that about half of the angiosperm species are polyploids. Two types of polyploids are known: autopolyploids, involving the reduplication of the same genom; and allopolyploids, involving the duplication of different genoms. The first type of polyploidy is not directly effective in speciation, although the polyploid differs from the diploid in certain morphological and physiological characters. Autopolyploidy does, however, serve to isolate the new form, since it is sterile with, and has a greater range than the diploid ancestor. In a recent survey of autopolyploidy Müntzing (1936) shows that such polyploids are generally more vigorous and hardier than the diploid forms and that the chromosome races are ecologically different. There is also a strong tendency for the polyploids to be perennials. Allopolyploidy is directly effective in producing new species, since such polyploids result from species hybridization, followed by chromosome doubling. The duplication of each of the parental genoms restores fertility, and the hybrid breeds true. Thus the allopolyploid is a constant species hybrid which has the characteristics of a true species, and in the case of generic crosses the allopolyploid may merit generic rank. Allopolyploids are known to occur in nature and in cultivation, and have been produced experimentally in several different families. The various types of allopolyploids have been described by Winge in 1932; and since that time a number of new cases have been discovered, so that we now have records of about fifty allopolyploids, of which eight are known to have originated in nature. It is significant that many of our most important crop plants are of known or supposed allopolyploid origin.

The general occurrence of polyploidy in the angiosperms has led to a detailed study of the causes of chromosome doubling in gametes and egg cells. In 1923 De Mol found that diploid pollen grains could be induced in *Hyacinthus* by subjecting the bulbs to abnormal environmental conditions. Belling (1925) found that low temperatures caused the production of diploid pollen grains in *Stizolobium*, *Uvularia*, and

Datura; and similar results were found in *Epilobium* and *Oenothera* by Michaelis (1928). The experimental work of Sakamura and Stow (1926) showed that high temperatures are also effective in producing diploid pollen grains. Shimotomai (1927) was able to produce giant pollen grains in *Liriope* and in *Scilla* by cold treatment. The effect of temperature treatment is produced by inhibiting the normal meiotic division so that no reduction of chromosomes occurs; but the factors involved are not well known.

The production of diploid gametes is undoubtedly an important factor in the formation of polyploid races or species in nature, even though sterile triploids would be formed more frequently than the relatively fertile tetraploids, especially in cross-pollinated species. The origin of polyploidy by the union of diploid gametes is dependent upon the frequent occurrence of chromosome doubling; but chromosome doubling in the fertilized egg, or at a later stage in somatic development, is directly effective in producing fertile polyploids. This mechanism is known to occur naturally, and has been used under experimental control. Randolph (1932) has been able to double the chromosome number in the fertilized egg cell of *Zea* by subjecting the plant to a temperature of 43°C. for about half an hour at the time the fertilized egg cell was presumably in the resting or early prophase stage. This technique has also been successful with wheat and rye (Dorsey 1936).

EXPERIMENTAL PRODUCTION OF POLYPLOID POLLEN GRAINS

During the past few years we have found occasional diploid pollen grains in plants of *Rhoeo discolor* grown in the greenhouse, where they were subject to moderate variations in temperature. Plants kept in the cold pit, at a temperature of about 5°C. for several days and then returned to the greenhouse, produced many diploid pollen grains. Last year we installed constant temperature chambers where the plants could be kept under control and studied more carefully.

We found that plants of *Rhoeo discolor* would produce some diploid pollen grains when subjected to either high or low temperatures for several days; but more consistent results were obtained when the plants were kept at a temperature of about 10°C. for two or three days and then kept at a temperature of 36°C. for one day. After treatment the plants were returned to the greenhouse and examined every few days.

Under normal conditions the chromosome pair at meiosis to form a ring or chain of 12 chromosomes. Adjacent chromosomes often pass to opposite poles so that each daughter cell receives six chromosomes.

These divide equationally to produce microspores with six chromosomes (Fig. 2). There is usually some irregularity in the chromosome distribution at meiosis, so that about 80 per cent of the pollen grains are sterile and undeveloped. The viable pollen grains contain an elongated dark-staining generative nucleus and a degenerate tube nucleus (Fig. 2A).

The first effect of the temperature treatment is the production of asynapsis. At metaphase the chromosomes are unpaired, and the twelve univalents lie on an equatorial plate (Fig. 1). The equational division of the univalent chromosomes produces a dyad with twelve chromosomes in each cell. In most cases these dyads develop independently to produce diploid microspores (Fig. 3) which develop into diploid pollen grains (3A). Since each microspore contains all twelve chromosomes, there is no deficiency of chromosomes or chromosome segments, and the microspores produce normal pollen grains. There is very little sterility of diploid pollen grains, and certain anthers show almost perfect pollen development as contrasted with about 80 per cent sterility in the normal diploid.

The temperature variation also produces tetraploid microspores. Meiosis is suppressed, and the twelve univalents divide, but there is no nuclear division. The chromosomes pass into the resting stage, and the entire microsporocyte develops as the microspore. There are twenty-four chromosomes in the microspore which divide to form the two nuclei of the pollen grain (Fig. 4). The differentiation of the generative and tube nucleus is seldom complete, although a few giant pollen grains are produced which appear to be normal (Fig. 4A). These tetraploid pollen grains are not produced regularly, and a single anther never contains only this class of pollen grains. They are found in small numbers associated with haploid pollen grains.

In rare cases the univalent chromosomes divide, and the daughter nuclei are formed, but no cell wall is formed to produce a dyad. The microsporocyte functions as a microspore with two nuclei, each with twelve chromosomes. In microspore development each nucleus divides (Fig. 5), and a pollen grain is produced which has two generative and two tube nuclei (Fig. 5A).

Diploid pollen grains have also been produced in species of *Tradescantia*, but only when the plants have been subjected to low and high temperatures. Cold or heat treatment alone is rarely effective in producing polyploid gametes in this genus. The first indication of reaction to temperature treatment is partial asynapsis; further reaction causes complete asynapsis with irregular division of chromosomes; and with

extreme treatment, the univalents divide equationally to form diploid pollen grains.

The effect of temperature treatment appears to be caused by disturbing the synchronization of nuclear and cytoplasmic activities. This effect is especially clear in the development and differentiation of the generative and tube nucleus in microspore development in *Tradescantia* (Sax 1935). In the microsporocyte the temperature change prevents chromosome pairing. The development of the chromosomes is accelerated in relation to other nuclear and cytoplasmic activities so that the univalents are ready to divide at the first instead of the second meiotic division. They may divide before nuclear division is possible so that the chromosome number is doubled. This is the mechanism involved in the production of tetraploid pollen grains of *Rhoeo* and the tetraploid egg cells of *Zea* and *Triticum*.

THE ORIGIN OF POLYPLOIDY IN NATURE

The occurrence of polyploidy in nature has been attributed to extreme temperatures. The tetraploids may have a more northern range than the diploids (Tischler 1935, Anderson and Sax 1936), or a more alpine distribution (Manton 1934), or may show a greater distribution along the seacoast (Tischler 1935). In such habitats a species would be subjected to greater temperature variations. The extreme temperature changes may cause polyploidy as the diploid races extend into unfavorable territory, but it is also possible that the polyploids have originated before the extension of the range, and because they are hardier, they extend their range into more extreme environments.

There are a number of cases where the forms in the northern areas or in extreme environments are more frequently diploid than the related varieties or species in more favorable environments (Böcher, 1936; Rohweder, 1936). One might expect that any extreme change in habitat might induce polyploidy, and that polyploidy would be expected at the periphery of the range, either northern or southern, or at low or high elevations. There is some evidence that different genera vary greatly in response to temperature changes. In many cases there is a definite cycle in gamete development which may serve as an adaptation to extreme diurnal temperatures. In the cereals, for example, the meiotic divisions tend to occur between 6 A. M. and 8 A. M., and it is possible that the more critical prophase stages are synchronized so that they are not often subjected to great variations in temperature.

The experimental evidence obtained with *Rhoeo* and *Tradescantia* indicates that polyploidy may be induced by rather moderate tempera-

ture changes in certain genera, but that rather extreme and sudden changes are more effective. Neither constant heat nor constant cold seems to be effective. Since extreme variations in temperature are most likely to cause polyploidy, one might expect polyploidy in nature to occur in regions of high altitude, in semi-arid regions, or along the sea-coast, where the changes in temperature are often rapid and extreme. The polyploid economic plants appear to have originated in such regions. Of the seven centers of distribution described by Vavilov (1932), five are regions of high elevation. Most of the economic plants of polyploid origin—including apples, pears, wheat, oats, potatoes, tobacco, and upland cotton—have originated in the mountains or foothills in the subtropics or tropics.

The increased vigor and hardiness of the polyploids are known to be associated with an increase in range of distribution in certain genera. We should expect that polyploids might be more frequent than diploids at the periphery of the range. Many species of plants in North America originated in Asia. A comparison of Asiatic and American species grown in the Arnold Arboretum shows that polyploidy is more frequent in the American species of *Malus, Rosa, Acer, Staphylea,* and *Ulmus,* while the reverse is true for *Lonicera* and *Fraxinus*. Many genera, such as *Rhododendron,* are represented entirely, or almost completely, by diploid species in both the old and new world. The data are hardly adequate for a critical survey, but the significance of polyploidy undoubtedly varies in different genera.

EXPERIMENTAL POLYPLOIDY

Work on experimental polyploidy is being conducted at a number of research laboratories. Belling (1925) has called attention to the value of triploids in ornamental plants where seed production is not desired. The use of diploid gametes, formed without a reduction division, should be of value in breeding heterozygous horticultural varieties. In the apple, for example, the varieties are so heterozygous that breeding new varieties is largely a matter of chance; but the union of diploid gametes should combine all the characters of the parental trees.

In the production of auto- and allopolyploids Randolph's method of doubling the chromosome number in the fertilized egg seems to be the most practicable. Our experimental work indicates, however, that it is advisable to precondition the plant in a cold chamber before subjecting the fertilized egg to high temperatures. I have been told that the heat treatment alone is not effective in doubling the chromosomes in *Zea* in the southern states. The failure of chromosome doubling in southern

regions presumably is caused by the relatively high temperatures of the normal environment, so that there is insufficient range of temperature to cause chromosome doubling. Under such conditions the cold treatment is necessary, and probably most plants would show a better response when subjected to an extreme temperature range.

Either the transition from cold to heat or from heat to cold seems to be effective in causing polyploidy. In experimental work the cell activities can be timed somewhat better if the plant is first subjected to cold treatment.

SUMMARY

Plants of *Rhoeo discolor* subjected to sudden temperature changes produced many diploid pollen grains, and a few tetraploid pollen grains. Chromosome doubling is caused by the suppression of meiosis and an equational division of the chromosomes to produce dyads which develop into diploid pollen grains. Occasionally the chromosomes divide without nuclear division to produce a monad which develops into a tetraploid pollen grain. Double diploid pollen grains may be produced which have two generative and two tube nuclei. Chromosome doubling appears to be caused by disturbing the synchronization of nuclear and cytoplasmic activities.

The effect of temperature variations in causing polyploidy in nature is discussed in relation to plant distribution and the centers of origin of cultivated plants. In the experimental production of polyploidy extreme temperature changes are more likely to be successful.

The temperature chambers used in this work were paid for, in part, by a grant from the American Academy of Arts and Sciences.

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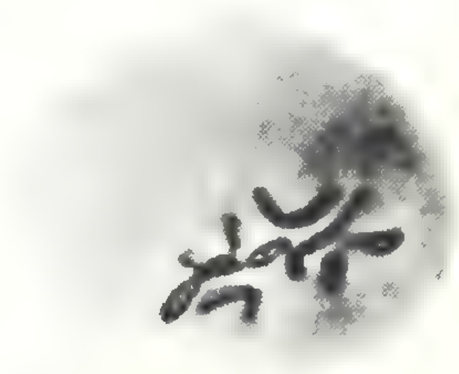

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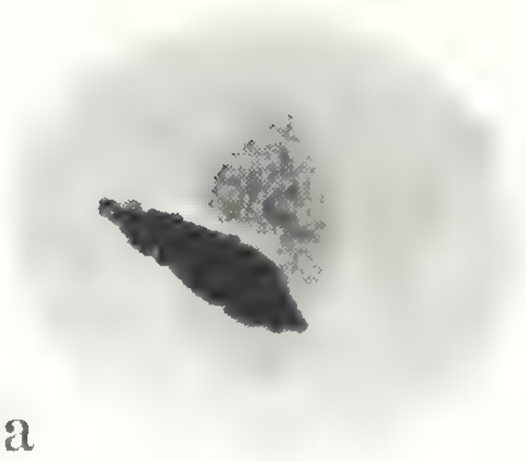

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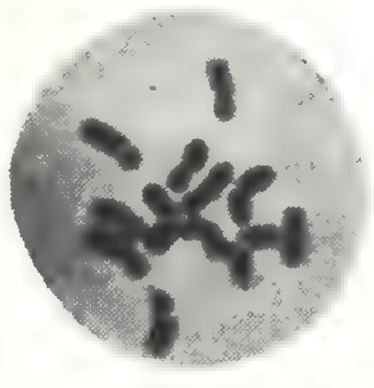

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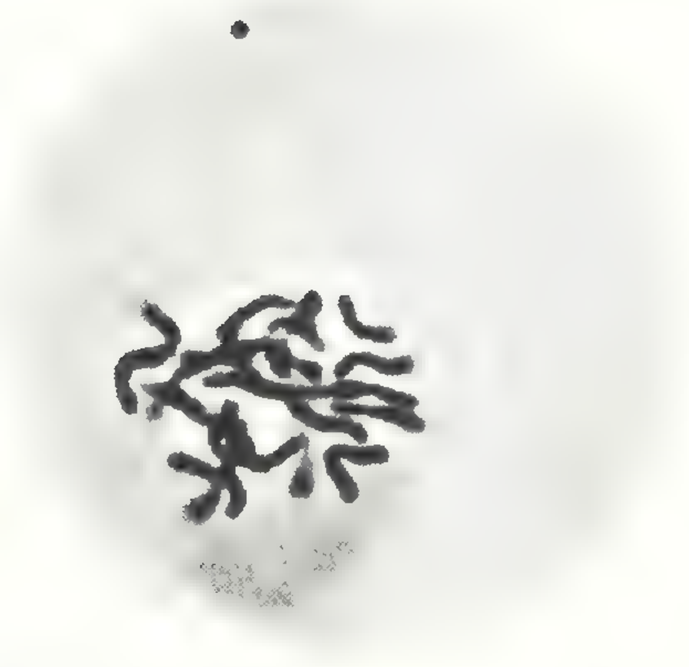

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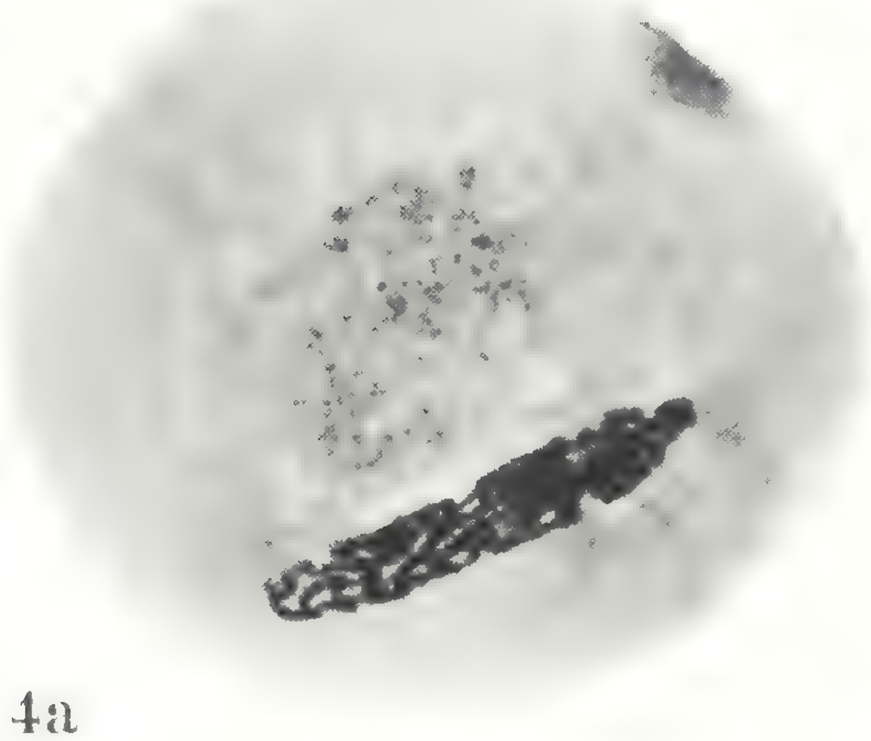

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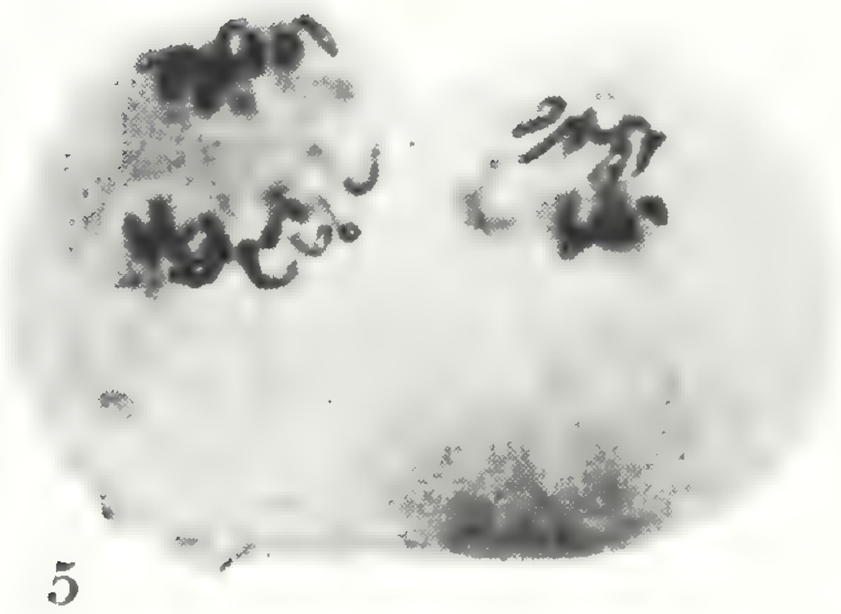

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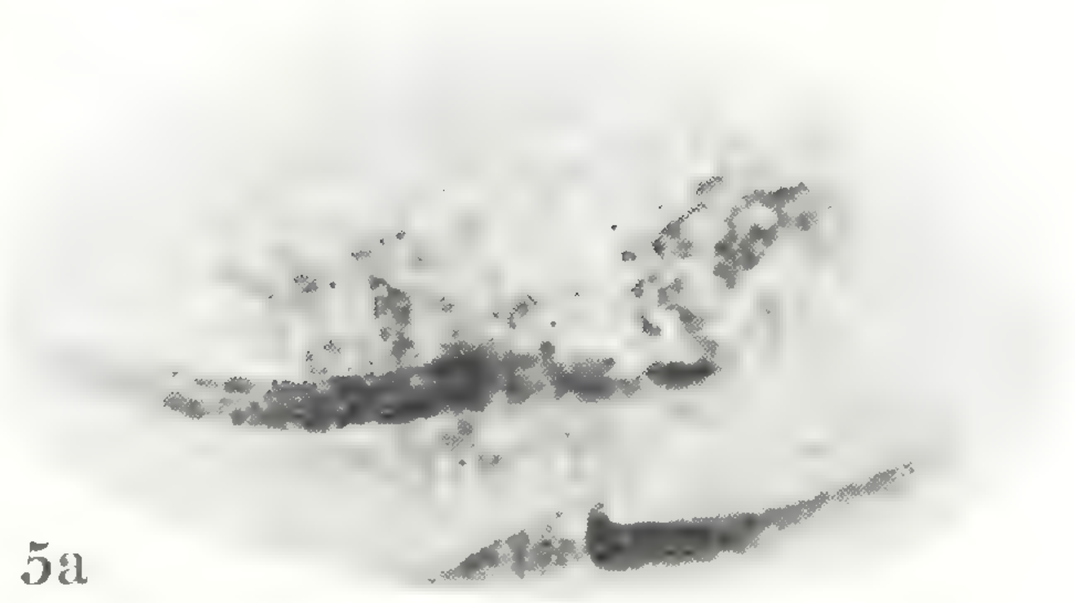

5a

EXPERIMENTAL PRODUCTION OF POLYPLOIDY

FULL-TONE — MERIDEN

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DESCRIPTION OF PLATE 189

Photographs of microspores and pollen grains of *Rhoeo discolor*. Aceto-carmine preparations. × 900.

Fig. 1. Pollen mother cell with induced asynapsis. The twelve univalents divide equationally.
Figs. 2 and 2A. A normal haploid microspore with 6 chromosomes, and the normal haploid pollen grain.
Figs. 3 and 3A. A diploid microspore produced by temperature treatment, and a typical diploid pollen grain.
Figs. 4 and 4A. A tetraploid microspore induced by temperature treatment, and a well-differentiated tetraploid pollen grain.
Figs. 5 and 5A. A double diploid microspore produced by equational division of the 12 univalents and nuclear division without cell wall formation. The resulting pollen grain has two generative and two tube nuclei.

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STUDIES IN THE OAKS OF THE MOUNTAINS OF NORTHEASTERN MEXICO

CORNELIUS H. MUELLER

IN TWO collections of plants made for the Arnold Arboretum in the mountains of Nuevo Leon, Mexico, by the author and Mary Taylor Mueller in 1934 and by the author in 1935 there are 250 numbers of oaks. A field study of considerable intensity from about May 6 to August 15, 1934 and from June 22 to August 15, 1935 has been supplemented by an herbarium study of the specimens collected.

The collecting and field study were carried on in the Sierra Madre Oriental south of Monterrey, Nuevo Leon. The localities cited in the treatment of the species are based upon names appearing on the topographic maps of the republic published by the *Secretaria de Agricultura y Fomento, Departmento de Geografía, Meteorologia e Hidrologia, Tacubaya, D. F., Mexico.* The maps are known as "*Carta de la República Mexicana en hojas a là 100,000a.*" Many of the names of ranches and cañons are local names not appearing on any maps. The term *municipio* (Mun.) refers to a political unit comparable to a county. A *municipio* takes its name from the town in which the seat of government is located.

In many of the species there was noted a high degree of variability which undoubtedly has in part led to the description of numerous poorly distinguished species. It will be noted that there are proposed many new names for forms not identical with, but surely conspecific with, previously known entities. These are given the rank of *forma* merely to call attention simultaneously to their differences from, and their conspecificity with, the typical forms with which they are allied, in the hope of avoiding their being regarded as distinct species, as they might readily be if one had not the intergrading forms to study and could not see the trees in the field.

The types of the new species and forms are deposited in the herbarium of the Arnold Arboretum (cited A. A.), Harvard University. The author wishes to acknowledge the excellent coöperation and financial aid of the Arboretum which made possible the collection of these plants.

Subgenus LEUCOBALANUS Engelmann

Series POLYMORPHAE Trelease

Quercus polymorpha Chamisso & Schlechtendal in Linnaea, **5**: 78 (1830).

NUEVO LEON: Mun. de Monterrey, Cañon Diente, alt. 700 to 1000 m., common on the wooded cañon floor and adjacent slopes, *No. 252*, May 6, 1934; Mun. de Galeana, cañon below Alamar on Hacienda Pablillo, common on the densely wooded cañon floor, alt. 1900 m., *Nos. 608* & *609*, May 29, 1934, *No. 632*, May 30, 1934, *No. 1143*, July 21, 1934.

Quercus polymorpha f. **angustifolia**, f. nov.

A typo recedit foliis anguste lanceolatis (3–4 × 10–14 cm.) integris vel versus apicem angustatum leviter dentatis, acumine plerumque obtuso.

NUEVO LEON: Mun. de Galeana, cañons about Alamar on Hacienda Pablillo, alt. 2000 m., *No. 610*, May 29, 1934, *No. 1144* (type in A. A.), July 21, 1934; Mun. de Villa Santiago, arroyo bottom between Las Adjuntas and Potrero Redondo, alt. 1300 m., *No. 2076*, July 3, 1935.

Series GLAUCOIDEAE Trelease

Quercus clivicola Trelease & Mueller in Bull. Torr. Bot. Club, **63**: 149 (1936).

NUEVO LEON: Mun. de Galeana, Cañon San Francisco on Hacienda Pablillo, abundant in the pine and oak wood of the cañon floor and slopes, alt. 2000 to 2200 m., *No. 286*, May 10, 1934, *Nos. 305*, *306*, & *309*, May 11, 1934, *No. 452*, May 18, 1934, *Nos. 1280*, *1285*, *1285A*, *1286*, & *1292*, July 31, 1934; common in the oak wood about Taray on Hacienda Pablillo, alt. 2200 m., *No. 423*, May 17, 1934, *No. 947*, July 2, 1934; in Cañon Santa Barbara on Hacienda Pablillo, alt. 2000 m., *No. 584*, May 25, 1934, *Nos. 1097* & *1098*, July 19, 1934; common about Alamar on Hacienda Pablillo, alt. 2000 m., *No. 974*, July 3, 1934, *Nos. 1103* & *1105*, July 20, 1934; Puerto de los Pastores near Galeana, alt. 1500 m., common on openly wooded slopes, *No. 1007A*, July 5, 1934, *No. 1295*, August 2, 1934; Mun. de Monterrey, Cañon Diente, alt. 900 m., common on the wooded cañon floor and slopes, *Nos. 1306* & *1306B*, August 8, 1934; Mun. de Villa Santiago, Cañon Guajuco above Villa Santiago, alt. 1300 m., common on openly wooded slopes, *No. 1331*, August 12, 1934, *No. 1356*, August 15, 1934.

Quercus clivicola f. **consanguinea** C. H. Mueller in Bull. Torr. Bot. Club, **63**: 150 (1936).

NUEVO LEON: Mun. de Galeana, Cañon Santa Barbara on Hacienda

Pablillo, alt. 2000 m., common in the pine and oak wood of the cañon walls, *No. 583,* May 25, 1934, *No. 1096,* July 19, 1934; about Alamar on Hacienda Pablillo, alt. 2000 m., scattered in the oak wood of relatively open slopes, *No. 1104,* July 20, 1934; Cañon San Francisco on Hacienda Pablillo, alt. 2100 m., abundant in the pine and oak wood of gentle slopes, *No. 1285B,* July 31, 1934.

Quercus clivicola f. **crenifolia** Trelease & Mueller in Bull. Torr. Bot. Club, **63:** 150 (1936).

NUEVO LEON: Mun. de Galeana, Cañon San Francisco on Hacienda Pablillo, alt. 2100 m., common in open oak wood, *No. 388,* May 14, 1934; about Taray on Hacienda Pablillo, abundant on openly wooded, gentle slopes, alt. 2200 m., *Nos. 421, 422,* & *425,* May 17, 1934; near Alamar on Hacienda Pablillo, abundant in open oak wood on gentle slopes, alt. about 2000 m., *No. 614,* May 29, 1934, *No. 701,* June 2, 1934, *No. 1145,* July 21, 1934, *Nos. 1173* & *1176,* July 22, 1934; Mun. de Villa Santiago, Potrero Redondo, alt. 1300 m., sparse in the luxuriant pine wood, *No. 2128,* July 5, 1935.

Quercus clivicola f. **dentata** Trelease & Mueller in Bull. Torr. Bot. Club, **63:** 150 (1936).

NUEVO LEON: Mun. de Galeana, Cañon San Francisco on Hacienda Pablillo, alt. 2100 m., abundant constituent of the pine-oak forest, *No. 322,* May 12, 1934, *Nos. 1284* & *1284A,* July 31, 1934; Cañon Santa Barbara on Hacienda Pablillo, alt. 2200 m., common in the pine-oak wood, *No. 1093,* July 19, 1934; Puerto de los Pastores near Galeana, alt. 1500 m., scattered on dry, openly wooded slopes, *No. 996,* July 5, 1934; Mun. de Linares, Cañon Santa Rosa near Iturbide, alt. about 1200 m., scattered in wooded arroyos, *No. 1294,* August 2, 1934.

Quercus clivicola f. **elongata,** f. nov.

A formis aliis differt foliis magis elongatis (2–3 × 10–12 cm.) plerisque supra crenatis vel dentatis.

NUEVO LEON: Mun. de Villa Santiago, Cañon Guajuco above Villa Santiago, alt. 1300 m., common in the low oak wood, *No. 1323* (type in A. A.), August 10, 1934; Mun. de Galeana, Taray on Hacienda Pablillo, alt. 2200 m., *No. 582,* May 25, 1934, *No. 1095,* July 19, 1934.

This form is close to both f. *crenifolia* and f. *dentata* in that the leaves are usually crenate or dentate above.

Quercus glaucophylla von Seemen in Bot. Jahrb. **29:** 95 (1900).

NUEVO LEON: Mun. de Galeana, Taray on Hacienda Pablillo, alt. 2200 m., sparse on the openly wooded slopes, *No. 590,* May 29, 1934; near Alamar on Hacienda Pablillo, alt. 2000 m., common on sparsely

wooded, dry slopes, *No. 596,* May 29, 1934, *No. 1121,* July 21, 1934; Puerto de los Pastores near Galeana, alt. 1500 m., scattered on sparsely wooded, dry slopes, *No. 1002,* July 5, 1934.

Quercus glaucophylla f. **lobata,** f. nov.

A formis aliis differt foliis typicis e basi ad apicem profunde lobatis, sinubus plerisque litteram U simulantibus.

NUEVO LEON: Mun. de Galeana, Cañon San Francisco on Hacienda Pablillo, alt. 2100 m., scattered on openly wooded limestone bluffs, *No. 1281* (type in A. A.), July 31, 1934; Puerto de los Pastores near Galeana, small tree sparse on openly wooded, gentle slopes, *No. 1003,* July 5, 1934.

Quercus glaucophylla f. **longifolia,** f. nov.

Ab aliis formis differt foliis elongatis (1.5–3 × 5–7.5 cm.) supra tantum leviter rotundo-lobatis.

NUEVO LEON: Mun. de Galeana, Taray on Hacienda Pablillo, alt. 2200 m., small tree, sparse in open oak wood on slopes, *No. 589* (type in A. A.), May 29, 1934.

Quercus glaucophylla f. **macropetiolata** C. H. Mueller in Bull. Torr. Bot. Club, **63:** 151 (1936).

In some cases this form has much longer petioles than those first described for it from Monterrey, some of them being as long as 16 mm.

NUEVO LEON: Mun. de Galeana, Cañon San Francisco on Hacienda Pablillo, alt. 2100 m., common on openly wooded slopes, *No. 307,* May 11, 1934; Alamar on Hacienda Pablillo, alt. 2000 m., common on openly wooded, dry slopes, *No. 1101,* July 20, 1934, *No. 1200,* July 23, 1934; Puerto de los Pastores near Galeana, alt. 1500 m., scattered on dry, openly wooded slopes, *No. 1001,* July 5, 1934; Mun. de Villa Santiago, Potrero Redondo, alt. 1300 m., common on steep, openly wooded slopes, *No. 2087,* July 4, 1935.

Quercus glaucophylla var. **subrotundifolia,** f. nov.

A formis aliis differt foliis majoribus (ad 5 × 6 cm.) ovalibus integris vel supra inconspicue crenatis.

NUEVO LEON: Mun. de Galeana, Cañon San Francisco on Hacienda Pablillo, alt. 2100 m., sparse on dry cliffs in the oak wood, *No. 1282* (type in A. A.), July 31, 1934.

Quercus verde, sp. nov.

Arbor parva ramis gracilibus (1–2 mm.) sulcatis incano-tomentosis, annotinis pubescentibus, lenticellis sparsis minutis vel majusculis conspicuisque; gemmae primum ovoideae et vix 1 mm. diam., demum acute ovoideae ad 2.5 × 3.5 mm. magnae, glabrae; stipulae subulatae, 5 mm.

longae, plerumque persistentes. Folia decidua, oblonga vel obovata, obtusa, saepe mucronulata, leviter cordata, integra vel apicem versus dentibus paucis latis brevibusque mucronulatis, margine minute revoluto plano vel crispo, supra lucidula et sparsissime stellata, subtus pallidiora, pilis stellatis canescentia, venis utrinsecus 8 vel 9 ramosis et anastomosantibus supra non sed subtus manifeste elevatis; petioli circiter 0.5–1 × 5–9 mm., dense stellato-pilosi. Amenta mascula 2.5–3.5 cm. longa, laxa, stellato-pilosa, antheris glabris breviter exsertis; amenta feminea 2–4-flora, pedunculo incano 1–2.5 cm. longo. Fructus annuus, non visus.

NUEVO LEON: Mun. de Galeana, Cañon San Francisco on Hacienda Pablillo, alt. 2100 m., scattered in low oak wood on a hilltop, *No. 373* (type in A. A.), May 14, 1934, *No. 451*, May 18, 1934; Cieneguillas on Hacienda Pablillo, alt. 2500 m., sparse in scrubby oak wood, *No. 886*, June 17, 1934.

A moderately small tree with rather gnarled branches and scaly gray bark. It occurs infrequently in open oak wood. From all other species of the section GLAUCOIDEAE except *Q. sororia* Liebm. (Overs. Dansk. Vidensk. Selsk. Forhandl. 1854, p. 175) this species differs in having twigs stellately incanous the first year and still quite hairy the second. From *Q. sororia* it differs in its very slender twigs and leaves hairy beneath. Its relationship to any one species in the series is problematic.

× **Quercus pastorensis**, hybr. nov. (*Q. glaucophylla* von Seemen × *Q. clivicola* Trel. & C. H. Muell.).

Ramuli, gemmae et fructus ut in *Q. glaucophylla;* ramuli et folia subtus persistenter pubescentes ut in *Q. clivicola;* folia nervatione *Q. glaucophyllam* referentia, sed textura et forma (oblonga margine crenata) *Q. clivicolae* similia.

NUEVO LEON: Mun. de Galeana, Puerto de los Pastores near Galeana, alt. 1500 m., common on openly wooded, dry slopes, *No. 1296* (type in A. A.) & *1297*, August 2, 1934, *Nos. 1000* & *1005*, July 5, 1934. *Nos. 1000* & *1297* seem to have resulted from a back cross with *Q. glaucophylla*. In them the characters of *Q. clivicola*, especially the hairiness of the leaves, are somewhat less evident.

Although the parents of this hybrid occur mixed over much of the range covered by this report, as well as in the type locality of the proposed hybrid, nowhere else was there noticed any evidence of hybridization. Since the type locality is a rather poor site bearing little woody vegetation, it may be that the hybrid is in this case less vigorous than the parents and therefore confined to an area in which the rigors of drought have much reduced the competition. It is doubtless true that many of the species reported in Mexico are hybrids which cannot be

recognized as such because of the extremely small amount of field study which has been carried on.

Series AURANTIACAE Trelease

Quercus monterreyensis Trelease & Mueller in Bull. Torr. Bot. Club, **63:** 151 (1936).

NUEVO LEON: Mun. de Monterrey, Cañon Diente, alt. 600 m., sparse in the dense oak wood, *No. 256,* May 6, 1934; Mun. de Villa Santiago, Cañon Guajuco above Villa Santiago, alt. 1300 m., common in rather dense oak wood along arroyos and on slopes, *No. 1315,* August 10, 1934, *Nos. 1328* & *1329,* August 12, 1934; Potrero Redondo, alt. 1300 m., scattered in open oak wood on gentle slopes, *No. 2080,* July 3, 1935.

Of these specimens *No. 1328* differs considerably from the other specimens in having leaves about half normal size both surfaces of which are sparsely stellate hairy. These differences hardly merit a name even as a form, for they often occur on the same tree as typical leaves and are to be regarded as a part of the normal variation of the species.

Series RETICULATAE Trelease

Quercus reticulata Humboldt & Bonpland, Pl. Aequinoct. **2:** 40 (1809).

NUEVO LEON: Mun. de Galeana, Cañon San Francisco on Hacienda Pablillo, alt. 2100 m., abundant along wooded waterways, *Nos. 303* & *304,* May 11, 1934, *No. 1279A,* July 31, 1934; above Alamar on Hacienda Pablillo, alt. 2300 m., sparse in low oak scrub, *No. 747,* June 4, 1934; Cañon de Cieneguillas above Pueblo San Francisco, alt. 2400 m., scattered along wooded waterways, *Nos. 1271* & *1272,* July 27, 1934.

This polymorphic species is quite difficult to delimit, for there appears to be as much variation within the species as there is between it and some others of the series, notably *Q. rhodophlebia* Trelease (in Mem. Nat. Acad. Sci. **20:** 74. 1924), *Q. Uhdeana* Trelease (l. c. 75), and *Q. pilicaulis* Trelease (l. c. 67).

Quercus reticulata f. **squarrosa** Trelease in Mem. Nat. Acad. Sci. **20:** 75 (1924).

NUEVO LEON: Mun. de Galeana, Cañon San Francisco on Hacienda Pablillo, alt. 2100 m., sparse with the species along arroyos, *No. 1279,* July 31, 1934.

Quercus reticulata f. **longa** Trelease in Mem. Nat. Acad. Sci. **20:** 75 (1924).

NUEVO LEON: Mun. de Galeana, Cañon San Francisco on Hacienda

Pablillo, alt. 2100 m., sparse with the species along arroyos, *No. 1279B*, July 31, 1934.

This form, like the above, is not distinct from the species but grades into it.

Quercus reticulata f. **pungens,** f. nov.

A typo recedit foliis 1.5 × 3 cm. vel minoribus profunde mucronato-dentatis in dimidio superiore, margine revolutis et manifeste undulatis.

NUEVO LEON: Mun. de Derrumbadero, Cañon de los Capulines above San Enrique on Hacienda San Jose de Raices, alt. 2500 m., shrub, rare on dry, shrub-covered slopes, *No. 2417* (type in A. A.), August 6, 1935.

Quercus revoluta Trel.[1] f. **acuta,** f. nov.

A typo recedit foliis magis elongatis (1–1.5 × 2–3.5 vel. 2 × 5 cm.) apice mucronatis acutissimis, dentatis vel integris, tomento subtus satis sparso.

NUEVO LEON: Mun. de Galeana, Puente de Dios near Galeana, alt. 1200 m., abundant shrub on dry, shrub-covered hills, *No. 2169* (type in A. A.), July 12, 1935.

Quercus Loeseneri Trelease in Mem. Nat. Acad. Sci. **20:** 79 (1924).

NUEVO LEON: Mun. de Galeana, slopes about Cieneguillas on Hacienda Pablillo, alt. 2400 m., sparse in the shrubs of the dry hills, *No. 882*, June 17, 1934; Cerro Potosí near Galeana, alt. 2700 to 3300 m., abundant low shrub in the pine forest, *No. 1263*, July 26, 1934, *Nos. 2225* & *2239*, July 20, 1935, *No. 2286*, July 24, 1935.

The distinction of this species from *Q. reticulata* seems very doubtful.

Series MICROPHYLLAE Trelease

Quercus microphylla Née in Anal. Cienc. Nat. **3:** 264 (1801).

NUEVO LEON: Mun. de Galeana, Cañon San Francisco on Hacienda Pablillo, alt. 2100 m., sparse shrubs on low-wooded slopes, Nos. *1291B* & *1291X*, July 31, 1934.

The preceding specimens are doubtfully referred to this species.

Probably the most confused group of white oaks and the last which will be satisfactorily understood is comprised of the various scrubby species of the desert mountain areas of northern Mexico and adjacent southwestern United States. One group, which seems to center about *Q. microphylla* and *Q. chihuahuensis* Trel., is represented in these collections by twenty numbers. The specimens show definite affinities to several species, but by reason of their high degree of intergrading can

[1]Trelease in Mem. Nat. Acad. Sci. **20:** 79 (1924).

only tentatively be referred to any species. It seems apparent that one of two conditions must be recognized. There might be an intricate system of closely related species which would many times multiply the number now known. To follow such an assumption would defeat the purpose of taxonomy. The only alternative which seems at present applicable is that there has been a high incidence of hybridization coupled with the natural variations of a profoundly fluctuating group of organisms. To classify satisfactorily such an entanglement will require field study of literally thousands of specimens and can hardly be undertaken in the study of a limited area such as the one now under consideration.

Series CHIHUAHUENSES Trelease

Quercus chihuahuensis Trelease in Mem. Nat. Acad. Sci. **20:** 85 (1924).

NUEVO LEON: Mun. de Galeana, Cañon San Francisco on Hacienda Pablillo, alt. 2100 m., abundant low shrub on low-wooded slopes, *Nos. 312* & *320*, May 12, 1934, *Nos. 1036* & *1037*, July 15, 1934, *Nos. 1288, 1288A, 1291,* & *1291A*, July 31, 1934; about Pablillo on Hacienda Pablillo, alt. 2000 to 2100 m., *Nos. 535* & *536*, May 21, 1934, *No. 885*, June 17, 1934, *No. 1091*, July 18, 1934; above Alamar on Hacienda Pablillo, alt. 2200 m., common low shrub in dry, open wood, *No. 748*, June 4, 1934, *No. 1158A*, July 22, 1934; Cerro Infernillo on Hacienda Pablillo, alt. 3000 m., a common shrub in the pine forest, *No. 847*, June 17, 1934; Cañon de las Placetas above Pueblo San Francisco, alt. 2300 m., abundant as an undergrowth in pine and oak wood, *No. 1274*, July 27, 1934; Cerro Potosí above Derramadero, alt. 2700 m., abundant low or creeping shrub in the pine forest, *No. 2280*, July 22, 1935; Arroyo Hondo near San Enrique on Hacienda San Jose de Raices, abundant on dry, shrub-covered slopes, *No. 2311*, July 31, 1935; Mun. de Villa Santiago, pass above Potrero Redondo, alt. 2100 to 2300 m., abundant in the shrub zones, *No. 2134*, July 7, 1935.

The preceding specimens have been referred only tentatively to this species.

Series OPACAE Trelease

Quercus Pringlei von Seemen in Bot. Jahrb. **29:** 96 (1900).

NUEVO LEON: Mun. de Galeana, about Pablillo on Hacienda Pablillo, alt. 2000 to 2200 m., sparse on dry, shrub-covered hills, a low shrub, *No. 880*, June 17, 1934, *No. 1090*, July 18, 1934; Puerto de los Pastores, alt. 1500 m., rare on dry, openly wooded slopes, *No. 995A*, July 5, 1934; Mun. de Derrumbadero, hills above San Juanito, alt. 2300 m., abundant shrub on dry slopes, *No. 2420*, August 10, 1935.

Quercus Pringlei f. **dentata**, f. nov.

A typo recedit foliis circiter triente inferiore excepto dentatis dentibus incurvis mucronatis, subtus initio flavo-stellato-tomentosis demum glabratis.

NUEVO LEON: Mun. de Galeana, about Pablillo on Hacienda Pablillo, alt. 2000 m., rare shrub on dry slopes, *No. 881* (type in A. A.), June 17, 1934.

Series UNDULATAE Trelease

Quercus undulata Torr. **Vaseyana** Rydberg in Bull. N. Y. Bot. Gard. **2:** 218 (1901).

NUEVO LEON: Mun. de Rayones, Casillas, alt. 1400 m., scattered on very dry and sparsely shrub-covered slopes, *No. 2167*, July 9, 1935. TAMAULIPAS: Mun. de Villa Mainero, bajada east of the mountains and north of Villa Mainero, alt. 500 m., rare in the dense scrub thorn forest, *No. 2431*, August 14, 1935.

The specimens agree perfectly with *Q. sillae* Trelease (in Mem. Nat. Acad. Sci. **20**: 102. 1924) which is described from the vicinity of Monterrey, Nuevo Leon, a short distance to the north of the localities here cited. There is no apparent morphological distinction and no reason why *Q. undulata* should not range south over similar habitats from western Texas.

Series PRINOIDEAE Trelease

Quercus Muehlenbergii Engelmann in Trans. Acad. St. Louis **3:** 391 (1877).

NUEVO LEON: Mun. de Galeana, Alamar on Hacienda Pablillo, alt. about 1900 m., large tree abundant in the densely wooded cañons, *Nos. 623* & *651*, May 30, 1934, *No. 1120*, July 21, 1934.

Series VIRENTES Trelease

Quercus fusiformis Small in Bull. Torr. Bot. Club, **28:** 357 (1901).

NUEVO LEON: Mun. de Villa Santiago, Cañon Denuncio above Rancho La Bola, alt. 750 m., abundant small tree in the more xerophytic oak wood, *No. 2013*, June 23, 1935.

Subgenus ERYTHROBALANUS Oersted

Series VIMINEAE Trelease

Quercus duraznillo Trelease in Mem. Nat. Acad. Sci. **20:** 122 (1924).

NUEVO LEON: Mun. de Galeana, Cañon San Francisco on Hacienda Pablillo, alt. 2100 m., shrub abundant on open slopes, *Nos. 369* (with definite indications of evergreen habit) & *374*, May 14, 1934, *Nos. 1289*,

1289A, & *1290*, July 31, 1934; Cerro Infernillo above Cieneguillas on Hacienda Pablillo, alt. 2700 m., common in low oak wood, *No. 845*, June 17, 1934; Mun. de Derrumbadero, hills above San Juanito, alt. 2500 m., common on very dry, open slopes, *No. 2419*, August 10, 1935.

In most of the collections the leaves tend to be toothed, but not so deeply as in f. *pinetorum* Trelease (in Mem. Nat. Acad. Sci. **20:** 123. 1924). The male catkins are scarlet when they first appear. The fruit is annual, paired on a short stalk, the cup scales shiny, light brown, almost glabrous, rounded or even truncate at the apex.

Series CRASSIFOLIAE Trelease

Quercus errans Trel.[1] f. **graciliramis,** f. nov.

A typo differt ramis gracilibus 2 mm. crassis et petiolis brevioribus; praeterea foliis manifeste sempervirentibus saepe ad basin dentatis et apice minus frequenter acutis.

NUEVO LEON: Mun. de Galeana, above Pablillo on Hacienda Pablillo, alt. about 2200 m., low shrub common in the dense, low oak wood of steep slopes, *Nos. 394* (syntype in A. A.), *395*, and *401*, May 14, 1934; Cañon de las Placetas above Pueblo San Francisco, alt. 2000 m., common low shrub on densely shrub-covered steep slopes, *No. 1273* (syntype in A. A.), July 27, 1934; Cerro Potosí above Derramadero, alt. 2800 m., abundant shrub 20 to 50 cm. high on pine-covered slopes, 1 to 2 m. high in arroyos, *No. 2224*, July 20, 1935.

The specimens show distinctly the biennial fruiting habit, and in some the catkins are well preserved. The latter have not been described for the species: staminate catkins 4–7.5 cm. long, the peduncle loosely hairy, rather densely flowered above and loosely below, the stamens exserted. Pistillate catkins 10–20 mm. long, 3–5-flowered, usually only the basal one developing into a single subsessile fruit.

Series ARISTATAE Trelease

Quercus Endlichiana Trelease in Mem. Nat. Acad. Sci. **20:** 141 (1924).

NUEVO LEON: Mun. de Galeana, slopes above Alamar on Hacienda Pablillo, alt. 2200 m., small tree about 7 m. tall, forming a dense wood, *Nos. 719* & *720*, June 4, 1934, *Nos. 1159, 1161,* & *1162*, July 22, 1934; Mun. de Villa Santiago, Cañon Guajuco above Villa Santiago, alt. 1400 m., small tree or shrub 3 to 6 m. tall, abundant in pine and oak forest, *No. 1330*, August 12, 1934.

Quercus Endlichiana f. **minor,** f. nov.

A typo differt foliis parvis (2–3.5 × 4–6.5 cm.) leviter dentatis denti-

[1]Trelease in Mem. Nat. Acad. Sci. **20:** 131 (1924).

bus setaceo-aristatis vel supra profunde incisis.

NUEVO LEON: Mun. de Galeana, slopes above Alamar on Hacienda Pablillo, alt. 2200 m., small tree about 4 m. tall, scattered in the pine and oak wood, *Nos. 718, 728,* & *729,* June 4, 1934, *Nos. 1157* (type in A. A.) & *1158,* July 22, 1934; Mun. de Villa Santiago, Potrero Redondo, alt. 1400 m., moderate tree some 8 m. tall, growing on a dry, openly wooded slope, *No. 2112,* July 4, 1935, *No. 2127,* July 5, 1935.

Quercus Endlichiana f. **serrata,** f. nov.

A typo differt folius profunde incisis supra acute serratis.

NUEVO LEON: Mun. de Galeana, slopes above Alamar on Hacienda Pablillo, alt. 2200 m., small tree about 4 m. tall, scattered in the pine and oak wood, *No. 727,* June 4, 1934, *No. 1160,* July 22, 1934; near Taray on Hacienda Pablillo, alt. 2200 m., moderate tree about 7 m. tall, sparse in the pine and oak wood, *Nos. 585* & *587,* May 25, 1934; Mun. de Villa Santiago, Cañon Guajuco above Villa Santiago, alt. 1400 m., moderate tree abundant in oak and pine wood, *No. 1330A* (type in A. A.), August 12, 1934; Potrero Redondo, alt. 1400 m., moderate tree about 8 m. tall, abundant in the pine and oak forests, *No. 2126,* July 5, 1935.

These specimens and those of f. *minor* grade into one another almost imperceptibly.

Certain numbers of the series representing this species (notably *Nos. 1160, 1330* and *1330A*) very pointedly indicate a close relationship to *Q. aerea* Trelease (in Mem. Nat. Acad. Sci. **20:** 135. 1924.) in general appearance, leaf form, and ". . . resiniferous beneath so as to be of the color of 'bronzy old gold' . . .". The only point upon which certain of these specimens can be excluded from *Q. aerea* is that of the small round-ovoid buds of that species, and even so, certain of the less mature specimens of this series fit that description. Perhaps a comparison of this material with the types of *Q. Endlichiana* and *Q. aerea* would prove them identical. The description of the latter, however, is fragmentary, and it is to be hoped that the more fully described *Q. Endlichiana* be allowed to stand.

Series RYSOPHYLLAE Trelease

Quercus rysophylla Weatherby in Proc. Amer. Acad. **45:** 423 (1910).

NUEVO LEON: Mun. de Galeana, Alamar on Hacienda Pablillo, alt. 1900 m., tall tree, 20 to 25 m., common on densely wooded cañon floors, *Nos. 625* & *633,* May 30, 1934, and *No. 1123,* July 21, 1934; Mun. de Villa Santiago, Potrero Redondo, alt. 1400 m., common on densely wooded cañon floors, 15 to 25 m. tall, *No. 2113,* July 4, 1935.

Series EUGENIAEFOLIAE Trelease

Quercus pinnativenulosa, sp. nov.

Arbor parva ramulis glabris gracilibus sulcatis, lenticellis fulvis conspicuis; gemmae subfusiformes, circa 1.5 × 3 mm. magnae, acutae. Folia ut videtur decidua, subcoriacea, integra, anguste ovata vel pleraque lanceolata, utrinque acuta, raro basi late cuneata, satis parva (2 × 5 to 3 × 12 cm.), supra et infra glabra et lucida, venis utrinsecus circa 18 utrinque prominulis, tenuioribus alternantibus, fere horizontaliter divergentibus, juxta marginem minute revolutum manifeste anastomosantibus; petioli supra satis applanati, circa 1 × 3–5 mm., apicem versus lamina decurrente alati. Amenta mascula 4–5 cm. longa, laxa; inflorescentiae femineae pleraeque biflorae, circa 5 mm. longae. Fructus biennis; cupula leviter involuta, circa 12 mm. lata et intus 6 mm. alta; glans (immatura) ovoidea, leviter sericea, dimidio immersa, circa 6 × 12 mm. magna.

NUEVO LEON: Mun. de Villa Santiago, Cañon Guajuco above Villa Santiago, alt. 1400 m., scattered along an arroyo in open pine and oak wood, a moderately small tree with dark gray or black bark roughly furrowed or smooth on young trees, *No. 1342* (type in A. A.), August 13, 1934.

The relationship of this species to the EUGENIAEFOLIAE is quite plain in the short petioles, the entire glabrous leaves, and the number, forking, and horizontal disposition of the veins. It is most closely related to *Q. eugeniaefolia* Liebmann (in Overs. Dansk. Vidensk. Selsk. Forhandl. 1854, p. 145) from which it is distinguished by the revolute leaf margins, less prominently winged and longer petioles, and usually less prominent veins beneath as well as by its being entirely glabrous save the staminate catkins and the cup scales. *Quercus eugeniaefolia* f. *petiolata* Trelease (in Mem. Nat. Acad. Sci. **20:** 161. 1924.) is closer to *Q. pinnativenulosa* in appearance according to Trelease's illustration (pl. 316b), but the same illustration shows the former to be annual fruited which the proposed new species is definitely not. The meagerness of published descriptions makes the distinction of this species difficult even though the great discrepancy in range and the quite different appearance would lead one to expect a more ready distinction.

Series LANCEOLATAE Trelease

Quercus affinis Scheidweiler in Hort. Belg. **4:** 321 (1837).

NUEVO LEON: Mun. de Galeana, Cañon San Francisco on Hacienda Pablillo, alt. 2100 m., abundant along densely wooded waterways, a slender, moderate tree, *No. 310,* May 11, 1934, *No. 1283,* July 31, 1934; Cañon Santa Barbara on Hacienda Pablillo, alt. 2200 m., abundant in

dense pine and oak wood, *No. 579*, May 25, 1934; Taray on Hacienda Pablillo, alt. 2100 m., abundant in low, dense oak wood, *No. 1102*, July 20, 1934; Cañon de las Placetas above Pueblo San Francisco, alt. 2100 m., common along a densely wooded waterway, *No. 1232*, July 25, 1934; between Puerto de Agua Sarca above Alamar on Hacienda Pablillo and Los Toros, alt. 2000 to 2500 m., *Nos. 2422* & *2423*, August 10, 1935, *No. 2424*, August 11, 1935.

Series TRIDENTES Trelease

Quercus chrysophylla Humboldt & Bonpland in Pl. Aequinoct. **2:** 42 (1809).

NUEVO LEON: Mun. de Galeana, Cañon de las Placetas above Pueblo San Francisco, alt. 2200 m., rare along a wooded waterway, *No. 1231*, July 25, 1934.

Series MEXICANAE Trelease

Quercus mexicana Humb. & Bonpl. f. **Bonplandii** Trelease in Mem. Nat. Acad. Sci. **20:** 174 (1924).

NUEVO LEON: Mun. de Galeana, Cañon San Francisco on Hacienda Pablillo, alt. 2100 m., abundant on openly wooded slopes, *No. 308*, May 11, 1934, *No. 1100*, July 19, 1934.

Series SALTILLENSES Trelease

Quercus flocculenta, sp. nov.

Frutex vel arbor parva ramulis 1–2 mm. crassis sulcatis stellato-incanis vel glabrescentibus; gemmae acute ovoideae, 1.5 × 2 mm. magnae. Folia decidua, firma et subcoriacea, 1–2 × 3–7 cm. magnae, anguste lanceolata vel oblonga, pleraque acuta, basi rotundata vel late subcuneata, integra vel apicem versus dentibus pluribus vel uno aristatis, margine plana, supra lucida et sparse stellato-pilosa secus costam et ad basin, subtus tomento stellato-canescente detergibili, et facie denudata minutissime bullato-granulari, venis utrinsecus 8–10, ramosis et anastomosantibus, subtus prominentibus supra vix visibilibus, reticulo venularum leviter elevato; petioli 0.5 × 4–7 mm. tomento canescente persistente sed detergibili; stipulae cito caducae. Amenta masculo circa 3 cm. longa, laxa, stellato-pilosa; amenta feminea 1–2-flora, pedunculo 1–2 × 5–10 mm. magno stellato-piloso. Fructus annuus; cupula juvenilis obconica squamis obtusis puberulis vel interdum glabris.

NUEVO LEON: Mun. de Galeana, Cañon de Cieneguillas above Pueblo San Francisco, alt. 2400 m., abundant on openly wooded slopes, shrub or small tree with low, spreading habit, *No. 1277* (type in A. A.), July 27, 1934; slope of Cerro Potosí above Derramadero, alt. 2800 m., low tree abundant along a cut-over waterway, *No.*

2279, July 22, 1935; Mun. de Derrumbadero, above San Juanito toward Agua Sarca, *No. 2418*, August 10, 1935, *No. 2427*, August 11, 1935.

The slender petioles, raised and looping venation, and the acute, usually entire, crisped leaves of *Q. flocculenta* indicate a relationship to the SALTILLENSES. But the rather extreme canescence of the leaves and twigs accentuates the differences between this species and those of the series SALTILLENSES, so that one hesitates to include it therein although it fits more readily there than elsewhere.

Quercus flocculenta f. **incisa**, f. nov.

A typo recedit foliis supra profunde incisis lobis aristatis, margine revoluto cripso.

NUEVO LEON: Mun. de Galeana, Cañon de Cieneguillas above Pueblo San Francisco, alt. 2400 m., common with the species, *No. 1276* (type in A. A.), July 27, 1934; near Pablillo on Hacienda Pablillo, alt. 2200 m., common on rather dry slopes in piñon and scrub oak wood, *No. 802*, June 15, 1934.

Quercus flocculenta f. **oblongifolia**, f. nov.

Ab aliis formis differt foliis oblongis 2–6 cm. longis subtus minus pubescentibus.

NUEVO LEON: Mun. de Galeana, Cañon de Cieneguillas above Pueblo San Francisco, alt. 2400 m., along arroyos in more mesophytic habitats with the species, *Nos. 1229* (type in A. A.) & *1230*, July 25, 1934, *No. 1275*, July 27, 1934; Mun. de Villa Santiago, puerto above Potrero Redondo, alt. 2300 m., abundant in the scrub oaks of a ridge top, *No. 2129*, July 7, 1935.

Quercus galeanensis, sp. nov.

Frutex ramulis dense breviter stellato-pilosis, demum furfuraceis sulcatis 1–1.5 mm. crassis; gemmae acutae, 1 × 2 mm. magnae. Folia firma et crassa, oblonga vel lanceolata 0.8–1.5 × 2–3.5 cm. magna, integra vel supra profunde et setose dentata, pleraque acuta, basi cuneata vel rotundata vel cordata, margine manifeste revoluta, glabra basi costae supra et ima basi laminae ciliata exceptis, nervis utrinsecus 5–8 cm. cum intermediis, utrinque leviter elevatis, vix anastomosantibus in dentes si adsunt exeuntibus, angulo angusto divergentibus; petioli 1 × 3–5 mm. magni, glabri facie superiore excepta. Fructus annui solitarii vel bini pedunculo 2–8 mm. longo suffulti; cupula juvenilis squamis majusculis arcte appressis obtuse brunneo-acuminulatis glabris.

NUEVO LEON: Mun. de Galeana, hills about Puente de Dios near Galeana, alt. 1200 m., abundant on dry slopes, *No. 2168* (type in A. A.), July 12, 1935.

This species seems closely related to *Quercus saltillensis* Trelease from which it may be distinguished by the usual toothing, the localization of pubescence, and glossy lower surfaces of the leaves of *Q. galeanensis*. It is a large shrub abundant on dry slopes associated with piñon, sumac, and other low oaks.

Quercus saltillensis Trelease in Mem. Nat. Acad. Sci. **20**: 183 (1924).

NUEVO LEON: Mun. de Galeana, slopes of Cerro Infernillo above Cieneguillas on Hacienda Pablillo, alt. 2700 m., common in low oak wood, *Nos. 845* & *848*, June 17, 1934; below Cieneguillas on Hacienda Pablillo, alt. 2200 m., sparse in shrub zones on dry hillsides, *No. 887*, June 17, 1934; Cañon San Francisco on Hacienda Pablillo, common on open, shrub-covered hills, *No. 1290*, July 31, 1934.

Series ACUTIFOLIAE Trelease

Quercus alamarensis, sp. nov.

Arbor parva, glabra ramulis gracilibus 1.5–2 mm. crassis sulcatis conspicue lenticellatis; gemmae ovoideae, obtusae, 1.5 × 2 mm. magnae, squamis obscure brunneis leviter ciliolatis. Folia decidua, anguste lanceolata, 2–3 × 8–12 cm. magna, integra vel raro setis una vel duobus marginalibus instructa, longe acuta, basi rotundata vel late cuneata, supra lucide glauco-viridia, subtus cuprea, nervis utrinsecus circiter 10 ramosissimis et anastomosantibus, ut costa utrinque elevatis; petioli 1 × 15–20 mm. Amenta feminea biflora pedunculo 3–6 mm. longo; squamae cupula juvenilis squamis leviter verruculosis. Fructus annuus.

NUEVO LEON: Mun. de Galeana, Alamar on Hacienda Pablillo, alt. 2000 m., rare in open wood along arroyos, *No. 613* (type in A. A.), May 29, 1934.

Small tree with roughly furrowed, black bark and a moderately branched habit. It is only by the nature of the veins that this tree can be entirely excluded from the species *Quercus Canbyi* Trel., although its leaf form would make it quite a strange phase of that species.

Quercus Canbyi Trelease in Mem. Nat. Acad. Sci. **20**: 188 (1924).

NUEVO LEON: Mun. de Galeana, Alamar on Hacienda Pablillo, alt. 1900 to 2100 m., common in wooded cañons, *Nos. 615* & *616*, May 29, 1934, *No. 1177*, July 22, 1934, *Nos. 1203* & *1225*, July 23, 1934; Puerto de los Pastores, alt. 1500 m., scattered on open slopes, *Nos. 1007* & *1008*, July 5, 1934; Cañon Santa Barbara on Hacienda Pablillo, alt. 1900 m., abundant in a densely wooded waterway, *No. 1094*, July 19, 1934; Mun. de Monterrey, Cañon Diente, alt. 800 m., abundant on

openly wooded, dry slopes, *No. 1305*, August 8, 1934; Mun. de Villa Santiago, Cañon Marisio Arriba above Las Adjuntas, alt. 1300 m., abundant on drier slopes, *No. 2051*, June 25, 1935; Potrero Redondo, alt. 1500 m., common on drier slopes, *Nos. 2090* & *2100*, July 4, 1935.

The forms of this species are many of them doubtless only ecological phases. They are significant taxonomically only because of the danger of their being regarded as distinct species.

Quercus Canbyi f. **attenuata**, f. nov.

A typo differt omnibus partibus diminutis; ramulis 1–2 mm. crassis, gemmis 2 mm. longis, foliis 1–1.5 × 5–7 cm. magnis, cupula 9–10 mm. diam.; arbor parva.

NUEVO LEON: Mun. de Villa Santiago, Cañon Guajuco above Villa Santiago, alt. 1300 m., scattered with the species on dry slopes, *No. 1347* (type in A. A.), August 15, 1934; Mun. de Galeana, Puerto de los Pastores near Galeana, alt. 1500 m., sparse on dry slopes, *No. 1010*, July 5, 1934.

Quercus Canbyi f. **Karwinskii** (Trel.), comb. nov.

Quercus Karwinskii Trelease in Mem. Nat. Acad. Sci. **20**: 188 (1924).

NUEVO LEON: Mun. de Galeana, Puerto de los Pastores, alt. 1500 m., sparse with the species on dry, open wooded slopes, *No. 1006*, July 5, 1934.

Specimens have been collected which approach variously this proposed species of Trelease, and the one collection which seems undoubtedly to fit here shows by its relation to intergrades that it cannot be held distinct from *Q. Canbyi*. The chief character upon which *Q. Karwinskii* is distinguished in Trelease's key, that of cup scales not canescent, is encountered in various forms as well as typical *Q. Canbyi*. Notable intergrades in these collections are *Q. Canbyi* f. *setacea* and *No. 999* of f. *subovatifolia*.

Quercus Canbyi f. **pedunculata**, f. nov.

Differt a forma *attenuata* pedunculis 5–8 mm. longis.

NUEVO LEON: Mun. de Galeana, Puerto de los Pastores, alt. 1500 m., rare with the species, *No. 1009* (type in A. A.), July 5, 1934.

Quercus Canbyi f. **setacea**, f. nov.

A typo differt foliis lobis multo longioribus ad 15 mm. setaceo-aristatis aristis 5–6 mm. longis, apice longe attenuatis et plerumque integris.

NUEVO LEON: Mun. de Galeana, Puerto de los Pastores, alt. 1500 m., rare with the species, *No. 1011* (type in A. A.), July 5, 1934.

Quercus Canbyi f. **subovatifolia**, f. nov.

Differt foliis tenuioribus, ad 4.5 × 11 cm. magnis, basi saepe obtuse subcuneatis vel rotundatis.

NUEVO LEON: Mun. de Galeana, Puerto de los Pastores, alt. 1500 m., scattered on dry slopes with the species, *No. 999*, July 5, 1934; Alamar on Hacienda Pablillo, alt. 2000 m., common along densely wooded waterways, *No. 1203A*, July 23, 1934; Mun. de Villa Santiago, Cañon Guajuco above Villa Santiago, alt. 1200 m., scattered with the species on closely wooded slopes, *No. 1346*, August 15, 1934.

This form cannot be satisfactorily distinguished from the species, but its broad leaves together with minor differences, such as leaf texture very fine, give it such an aberrant appearance that only the many intergrades restrain one from regarding some of the specimens as distinct species. Leaves as large as 4.5 × 11 cm., the bases often obtusely subcuneate to broadly rounded. This form arises most commonly under conditions of shade and abundant moisture. It is an artificial group, and no one of the specimens cited may be designated as a type.

Quercus Sartorii Liebmann in Overs. Dansk. Vidensk. Selsk. Forhandl. 1845, p. 177.

NUEVO LEON: Mun. de Villa Santiago, Potrero Redondo, alt. 1500 m., sparsely scattered in open oak wood on rather dry, gentle slopes, low tree, *No. 2123*, July 5, 1935.

Quercus cupreata[1] f. **brachystachys**, f. nov.

A typo differt lenticellis prominentibus, foliis basi rotundatis vel subcuneatis, amentis femineis 5 mm. longis vel brevioribus (in typo 10–20 mm. longis).

NUEVO LEON: Mun. de Villa Santiago, Cañon Guajuco above Villa Santiago, alt. 1400 m., common in dense oak wood, *No. 1327* (type in A. A.), August 12, 1934; Cañon Denuncio above Rancho La Bola, alt. 900 m., sparse along a wooded waterway, *No. 2011*, June 22, 1935.

The specimens of this form bear mature fruits which are here described because those of the species are yet unknown: cups moderate (12–14 mm.), shallow (5 mm.), moderately inrolled, scales light brown, dark tipped, elongated and narrowly rounded, somewhat scurfy and ciliate; acorns small (10–11 mm. broad, 7–9 mm. long), hemispherical (flat at the base), obtusely conic above, depressed at the apex, silky, minutely striate.

Quercus cupreata f. **serrata** Trelease & Mueller in Bull. Torr. Bot. Club, **63**: 153 (1936).

NUEVO LEON: Mun. de Villa Santiago, Potrero Redondo, alt. 1400 m., abundant on densely wooded cañon walls, *Nos. 2078* & *2079*, July 3, 1935, *No. 2102*, July 4, 1935.

[1]Trelease & Mueller in Bull. Torr. Bot. Club, **63**: 152 (1936).

Quercus graciliramis, sp. nov.

Arbor glabra domatiis inconspicuis interdum in foliis repertis exceptis, ramulis 2–2.5 mm. crassis, manifeste sulcatis lenticellis parvis instructis; gemmae acutae, conicae, 1.5 × 2.5 mm. magnae. Folia decidua, lanceolata vel anguste ovata, 3.5–7 × 8–13 cm. magna, basi subcuneata, leviter serrata ad profunde incisa lobis in setas tenues 3–5 mm. excurrentibus, sinubus levibus vel profundis rotundatis, supra opaca, infra lucida et cuprea, margine plana nervis utrinsecus 4 vel 5 ut venulis leviter prominentibus; petioli supra applanati, 1 × 20–30 mm. Amenta feminea 5–10 mm. longa, 2–3-flora, pedunculo 1.5 × 5–7 mm. Fructus biennis; cupula juvenilis turbinata, margine leviter involuta, squamis tenuibus planis anguste rotundatis ciliatis canescentibus detersis pallide brunneis; glans juvenilis leviter stellato-puberula ad apicem applanatam et rotundatam.

NUEVO LEON: Mun. de Galeana, Alamar on Hacienda Pablillo, alt. 1900 to 2100 m., abundant along densely wooded waterways, *No. 1106* (type in A. A.), July 20, 1934, *No. 617,* May 29, 1934, *No. 1124,* July 21, 1934, *No. 1202,* July 23, 1934; Taray on Hacienda Pablillo, alt. 2100 m., common along waterways, *No. 1224,* July 23, 1934.

Moderate tree with long graceful branches and roughly furrowed, dark gray or black bark. The affinities of this species for *Quercus runcinatifolia* Trelease & Mueller (in Bull. Torr. Bot. Club, **63:** 153. 1936) as regards leaf characters and for other species of the section in fruit characters are no more marked than its apparently close relationship to *Q. albocinta* Trelease (in Mem. Nat. Acad. Sci. **20:** 193. 1924) upon which is based the series ALBOCINTAE Trel. Since the fruits of *Q. albocinta* are unknown, any comparison (or distinction) must be based upon leaf characters. In this regard the typical form of *Q. graciliramis* closely approximates *Q. albocinta,* and there comes to mind the suggestion that the series ALBOCINTAE may be more closely related to certain species of the ACUTIFOLIAE than are some of the species of the latter to one another. The only characters upon which there can be based any great distinction between *Q. albocinta* and the species of ACUTIFOLIAE are that in the former the veins invariably pass into the lobes, and that the leaf margins are broadly crisped. These characters may be seen as tendencies in *Q. graciliramis* and *Q. runcinatifolia,* and in the latter the white veins of *Q. albocinta* are quite common. *Quercus graciliramis* is readily distinguished from *Q. runcinatifolia,* to which it is closely related, by the fine texture of its leaves and by its prominent lenticels. When the fruits of *Q. runcinatifolia* become known, there will probably be more readily describable differences.

Quercus tenuiloba, sp. nov.

Arbor alta, glabra domatiis inconspicuis interdum in foliis repertis exceptis, ramulis 3 mm. crassis sulcatis obscure rubro-brunneis lenticellis prominentibus demum canescentibus lenticellis minus conspicuis instructis; gemmae conicae, 2 × 3 mm. magnae, acutae, apice pubescentes, squamis obscure brunneis ciliatis. Folia decidua, anguste attenuato-lanceolata, raro latiora, 3.5–5.5 × 12–17 cm. magna, basi quadrato-rotundata vel leviter cordata, pleraque supra leviter incisa sinubus rotundatis, lobis brevibus in setas 4–8 mm. longas exeuntibus, lobo terminali plerumque elongato-acuta, margine cartilagineo leviter revoluta, supra opaca, subtus lucida, cuprea, nervis utrinsecus 10–12 supra impressis subtus prominentibus, trabeculis satis conspicuis conjunctis, ramosis sed vix anastomosantibus; petioli supra applanati et leviter alati, 1.5 × 10–22 mm., plerique 20–22 mm. Amenta feminea biflora, circa 8 mm. longa. Fructus biennis; cupula juvenilis rotundata squamis tenuibus appressis canescentibus tomento deterso pallide brunneis.

NUEVO LEON: Mun. de Galeana, Alamar on Hacienda Pablillo, alt. 1900 m., sparse in densely wooded arroyos, *No. 1125* (type in A. A.), July 21, 1934, *No. 652,* May 30, 1934, *No. 1146,* July 21, 1934; Mun. de Villa Santiago, Cañon Marisio Arriba, above Las Adjuntas, alt. 1400 m., sparse in densely wooded waterways, *No. 2045,* June 25, 1935.

Large, tall tree with roughly furrowed, black bark, growing sparsely on very moist and densely wooded cañon floors. *Quercus tenuiloba* is quite distinct from other species of the series ACUTIFOLIAE, but it is apparently rather closely related to *Q. Grahami* Bentham (Plant. Hartweg. 57. 1840) and *Q. xalapensis* Humboldt & Bonpland (Pl. Aequinoct. **2:** 24. 1809) from both of which it may be distinguished by its veins impressed above and its squarely rounded leaf bases.

Quercus tenuiloba f. **gracilis,** f. nov.

A typo differt ramulis gracilibus 1.5–2 mm. crassis, foliis valde angustatis basi truncatis vel obtuse cuneatis; petiolis 3–4 mm. longis.

NUEVO LEON: Mun. de Villa Santiago, Cañon Marisio Arriba, above Las Adjuntas, alt. 1400 m., moderate, slender tree rare along densely wooded waterways, *No. 2048* (type in A. A.), June 25, 1935.

Quercus tenuiloba f. **hirsuta,** f. nov.

A typo differt ramulis hornotinis pilosis, annotinis furfuraceis, foliis subtus ad costam nervosque et supra ad basin costae stellato-pilosis; petiolis 6–10 mm. longis.

NUEVO LEON: Mun. de Villa Santiago, Potrero Redondo, alt. 1500

m., moderate, spreading tree sparse on openly wooded slopes, *No. 2122* (type in A. A.), July 5, 1935.

Quercus vexans Trelease in Mem. Nat. Acad. Sci. **20:** 190 (1924).

NUEVO LEON: Mun. de Villa Santiago, Cañon Guajuco above Villa Santiago, alt. 1500 m., abundant in dense oak wood on steep slopes, *Nos. 1326* & *1332*, August 12, 1934; Potrero Redondo, alt. 1400 to 1800 m., abundant constituent of dense oak wood on broad slopes, *No. 2121*, July 5, 1935, *No. 2130*, July 7, 1935.

No. 1332 exhibits what is apparently secondary growth giving the appearance of biennial fruit and evergreen foliage. The general fruiting habit, however, does not warrant any such conclusion.

DEPARTMENT OF BOTANY,
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PHYTOGEOGRAPHIC STUDIES IN THE ATHABASKA—GREAT SLAVE LAKE REGION

I. CATALOGUE OF THE VASCULAR PLANTS

HUGH M. RAUP

With plates 190–194 and map

INTRODUCTION

THE Athabaska–Great Slave Lake region lies in the central latitudes of the Mackenzie drainage basin of northwestern Canada, and occupies the eastern part of this central section. Roughly, it involves an area some 500 miles long by 350 miles wide, lying west of the 105th meridian and north of the 55th parallel. It consists almost entirely of virgin wilderness devoid of roads or other means of transportation except the primitive ones of the natural waterways and the sharply contrasting modern ones of the air. As a result of the difficulties of transport, especially in the country which does not lie immediately along the great rivers or lake shores, any detailed studies in natural history are bound to be greatly limited in geographic scope. In attempting generalizations, therefore, on the ranges of species or vegetations, it must be borne in mind constantly that there are vast "inland" areas which are virtually unknown biologically, and that many of these areas are terra incognita as well to the geologist and topographer. With very few exceptions the data upon which the following studies have been based were gathered from the "marginal" strips. The only hinterlands which have been examined with any degree of care are in the Wood Buffalo Park.

The present paper, containing a catalogue of the known vascular flora of this region, is to be followed by another devoted to a general description of the country and its vegetation, with historical notes on its botanical exploration. Taken together these papers are intended to form the third of a series of similar studies dealing with the central and southern portions of the Mackenzie basin.[1, 2] It will be noted at once

[1] RAUP, HUGH M. *Phytogeographic Studies in the Peace and Upper Liard River Regions, Canada, with a Catalogue of the Vascular Plants.* Contr. Arnold Arb. VI. (1934).

[2] ——— *Botanical Investigations in Wood Buffalo Park.* Nat. Mus. Can. Bull. no. 74 (Biol. Ser. No. 20) (1935).

that the area involved in the paper on the Wood Buffalo Park is included in that of the present one. To avoid duplication in the catalogue, and at the same time to make it usable for the whole region, detailed citations of Wood Buffalo Park specimens will be largely omitted, and notes on the occurrence of species there only summarized. On the other hand, since the vegetational studies to follow this catalogue are concerned mainly with the pre-Cambrian regions to the eastward of the Slave and lower Athabaska Rivers as well as about the eastern arm of Great Slave Lake, it has seemed advisable to permit a certain amount of overlap, and to include citations of specimens collected in the great river lowlands along the western borders of the crystalline rocks. The southern boundary of the area would, by this reasoning, be in the lower Athabaska valley, but here it has been extended southward rather arbitrarily so as to include the small amount of available botanical information about the Clearwater River country and that along the Athabaska up as far as Athabaska Landing. While studying earlier botanical records the writer has made a fairly exhaustive survey of the literature, and has been able to see most of the specimens in American herbaria collected in the entire Mackenzie basin except for the upper Athabaska River region. Consequently it has been possible to summarize for this larger area the known distribution of the species listed. It should be noted that collections made in recent years by A. E. & R. T. Porsild in the Great Bear Lake and lower Mackenzie districts may be expected to add greatly to our knowledge of many of these northern plant ranges.

The first comprehensive account of the flora of the Mackenzie basin was that contained in the classic *Flora Boreali-Americana,* by W. J. Hooker. It was completed in 1840, and so far as our region was concerned, was based almost entirely upon the collections made by John Richardson, that remarkable physician-naturalist who, between 1819 and 1827, accompanied the first and second expeditions of John Franklin through the northern interior of Canada. Very few additions to the known flora were made during the century following these expeditions. Macoun's Catalogue of Canadian Plants, the publication of which was finished in 1890, depended almost entirely, for its records in our region, upon Hooker's *Flora*. The only collection of particular note in this long interval was that of Robert Kennicott, made about 1860, but no account of it was ever published, nor has it been as a whole easily available to students. An excellent description of the ligneous flora was presented by E. A. Preble as a result of his biological reconnaissance work (chiefly zoölogical) in the Mackenzie basin in 1901 and 1903–4.[1]

[1]Preble, E. A. *A Biological Investigation of the Athabaska-Mackenzie Region.* U. S. Dept. Agr. — N. Am. Fauna No. 27 (1908).

The writer's own collecting was begun in the summer of 1926 on the lower Athabaska River and the northwest shore of Lake Athabaska. This has been followed by six other journeys to various parts of the region, netting about 4880 field numbers of vascular plants. This collection, together with its accumulated field notes, forms most of the foundation for the present catalogue. Wherever the earlier records could be authenticated by actual specimens, they have been included, and unauthenticated records have been noted in the text if they form significant or suggestive range extensions. In 1926 the known vascular flora of the entire Mackenzie basin east of the Rocky Mountains included approximately 600 species. In the past ten years this figure has been increased by something over 35%, with each new effort making substantial additions.

A more or less detailed history of the earlier collectors will be placed in another paper, as noted above. There also will be found a description of the writer's own itineraries. For present purposes the accompanying map and the following list of most of the collection localities should be sufficient to make the catalogue geographically intelligible.

Athabaska River and tributaries

Methye Portage: Lat. 56°40′, Long. 109°54′. On the height of land between the Saskatchewan and Mackenzie drainages.

Clearwater River: Collections noted thus came from the valley of this stream somewhere between Methye Portage and the Athabaska. Most of them evidently came from very near the Portage, since they are marked "Sask."

Waterways: A small settlement on the Clearwater River about 4 miles from McMurray by road. It is at the end of the railroad from Edmonton, and the present head of navigation on the Mackenzie waterways system.

McMurray: Lat. 56°44′, Long. 111°23′. At the junction of the Clearwater and Athabaska Rivers.

Athabaska Landing: Lat. 54°45′, Long. 113°15′. A town on the Athabaska River connected with Edmonton by road and train.

Lac la Biche: A lake about halfway between Edmonton and Waterways along the railroad. It drains westward into the Athabaska River. The town, from which a few specimens are cited, is at the eastern end of the lake.

Pelican Rapids: A small rapid in the Athabaska about 120 miles below Athabaska Landing.

Grand Rapids: An unnavigable rapid in the Athabaska about 85 miles above McMurray.

Calumet: Lat. 57°25′, Long. 111°38′. Collections are from the east bank of the Athabaska and neighboring uplands about 7 miles below Calumet Creek, just above Wheeler's Island.

Firebag River: Lat. 58°43′, Long. 111°21′. Collections are from woods and sloughs along this stream 2–3 miles above its entrance to the Athabaska.

Delta of Athabaska River: Collections are mainly from two localities, one near the mouth of the Embarras Channel (Lat. 58°36′30″, Long. 111°5′30″) and the other on Mamawi (Cree) Creek (Lat. 58°29′, Long. 111°30′).

Lake Athabaska

Chipewyan: Lat. 58°42′32″, Long. 111°10′.

Shelter Point: Lat. 58°50′, Long. 110°50′.

Sand Point: Lat. 58°56′, Long. 110°42′.

Charlot Point: Lat. 59°36′, Long. 109°13′. See map for details of collection localities (Ellis Bay, Charlot Isl., Charlot River, Camsell Portage).

Elliot Point: A small point about 8 miles east of Crackingstone Point (see map).

Cornwall Bay: Lat. 59°27′30″, Long. 108°27′30″. See map for detail of collection localities (Wabba Lake, etc.).

Fishhook Bay: Lat. 59°27′30″, Long. 108°23′30″. Collections are from a long narrow point which forms the inside curve of the "Hook".

Five miles east of Poplar Point: Lat. 59°29′45″, Long. 107°41′.

Wolverine Point: Lat. 59°9′, Long. 108°25′. See map for details of localities.

William Point: Lat. 59°7′30″, Long. 109°19′. See map for details.

Two miles west of Ennuyeuse Creek: Lat. 59°3′, Long. 109°34′. See map for details.

Lake Athabaska to Great Slave Lake

East shore of Lake Mamawi: Lat. 58°35′, Long. 111°22′. Collections from delta sloughs and from granite knolls.

Hay (Prairie) River: Lat. 58°37′, Long. 111°44′. A short, sluggish waterway between Lakes Claire and Mamawi.

Delta of Peace River: Most of the collections are from the Quatre Fourches River, a short stream flowing between Peace River and Lakes Athabaska and Mamawi. Near the Peace its banks are well wooded but near the lakes it flows through delta flats. A few collections so cited are from the Scow Channel, a northern branch of the Peace where it enters the Slave. For details of this and the following see citations in the writer's "*Botanical Investigations in Wood Buffalo Park.*"

Upper Slave River lowland: Collections are mostly from three localities, near the point where the 30th surveyed base line crosses the river (Lat. 59°7′, Long. 111°27′), the Murdock Creek district (Lat. 59°14′, Long. 111°34′), and the Government Hay Camp district (Lat. 59°31′, Long. 111°28′). They are mostly from the river lowlands and occasional granite knolls.

Fort Smith: Lat. 60°00′30″, Long. 111°53′. Collections are from the bank of the River, from the village itself, and from nearby sloughs and upland woods. A few are from the Portage Road near its eastern end, and from the vicinity of upper Smith Rapids near the town of Fitzgerald.

Lower Slave River: Most of the collections noted thus are from the banks of the river not far below Grande Detour, about 60 miles below Fort Smith.

Hill Island Lake: Lat. 60°30′, Long. 109°45′.

Tazin Lake: Lat. 59°50′, Long. 109°20′. Both this and the preceding are on the canoe route between the north shore of Lake Athabaska and the south shore of Great Slave Lake.

Great Slave Lake

Resolution: Lat. 61°10′, Long. 113°40′.

Mouth of Taltson River: Lat. 61°25′, Long. 112°45′.

Caribou Island: Lat. 61°55′, Long. 113°10′.

Keith Island: Lat. 62°3′, Long. 111°57′. Collections are from a small sandy cove on the western side of the island.

Taltheilei Narrows: Lat. 62°42′, Long. 111°25′. Collections here are not from the Narrows proper, but from a point on the north shore of the lake about 8 miles to the northeast.

North shore of McLeod Bay: Collections cited thus are mostly from the mouth of Mountain River.

Fairchild Point: Lat. 62°43′, Long. 109°10′. See map for details. Most of the collections are from the outer half of the long peninsula.

Maufelly Point: A long peninsula from the south shore of McLeod Bay which, with Fairchild Point, cuts off Charlton Bay.

Pike's Portage: See map for details.

Fort Reliance: Lat. 62°47′, Long. 108°55′. Site of Back's old fort (1833–5).

Yellowknife Bay: Lat. 62°25′, Long. 114°18′. Most of the collections are from the vicinity of the trading post, near the position given above.

Old Fort Rae: Lat. 62°38′, Long. 115°48′.

Fort Rae: Lat. 62°50′, Long. 116°4′.

Moraine Point: On the north shore of the western arm of the Lake, between Jones and Gypsum Points.

Slave Point: Lat. 61°12′, Long. 115°57′.

Windy Point: Lat. 61°18′, Long. 115°50′. This and the preceding are on the north shore of the west arm.

Artillery Lake: Lat. 63°5′, Long. 107°50′. The arctic margin of the timbered country crosses this lake about midway, and the position given above is approximately that of "Last Woods" on the east shore, from which many collections have come.

Casba Lake: Lat. 63°36′, Long. 107°25′. This is *Ptarmigan Lake* of recent maps.

Terms of frequency, such as *rare, occasional, frequent,* or *abundant* are self explanatory. Further notes upon the relative abundance of species and their positions in the various plant associations will be found in the subsequent paper. Most of the terms describing habitats also need no explanation except in one or two cases. A *muskeg* is an undrained depression whose cover consists mainly of mosses, the commonest of which are species of *Sphagnum.* In contrast to this the terms *slough* or *wet meadow* have been used to designate swamps whose cover is of grasses and sedges. In describing the ranges of plants, their positions have been approximated with relation to the major vegetation boundaries, as far as the latter are understood at present. One of these is the northern boundary of the timbered country, which passes through our region in the northeast. Another is the contact zone between the pre-Cambrian and Paleozoic rocks. This is one of the most conspicuous of the floral boundaries, and follows the Slave River valley northward to Great Slave Lake. The contact crosses the latter and is covered northward by the north arm of the lake itself. Another less conspicuous botanical transition area is in the lower Athabaska River region, where the valley leaves the highlands of Cretaceous sediments which border the Athabaska and Clearwater Rivers about McMurray. In summarizing the broader Mackenzie basin ranges of the species, a collector's name in italics has been added wherever the writer has seen a specimen. Otherwise the terms "recorded by" or "noted by" are used.

The order of the citation of specimens is that given in the above list of localities, and follows a geographic sequence. Where numbers are available they have been used, and if the record is one attributed to an earlier collector, the name is inserted in italics. Numbers without such names are the writer's own, except in the case of nos. 4395–4703, inc., which bear the name also of E. C. Abbe, who served as field assistant in the summer of 1932. The writer's collections from the Athabaska —

Great Slave Lake region are as yet undistributed, but are available for study at the Gray Herbarium or at the herbarium of the Arnold Arboretum. The following is a list of herbaria from which citations have been made in the list:

A — Arnold Arboretum.
G — Gray Herbarium, Harvard University.
N — New York Botanical Garden.
O — National Museum of Canada, Ottawa.
W — U. S. National Herbarium.
Ball — Private Herbarium of Carleton R. Ball.

In the selection of names the author has tried to adhere to the International Rules of Botanical Nomenclature. The order and definition of families is that of Engler and Gilg's "Syllabus der Pflanzenfamilien" (9th and 10th editions), and the order of genera follows the same work except in a few cases such as the Gramineae and Cruciferae. Synonyms have been inserted wherever they are essential for comparison with floristic works of reference touching the region. Owing to the fact that many years have elapsed since a comprehensive flora of any part of north temperate or arctic America has been published, it has been necessary to go to the files of periodical literature for recent revisions of a great many genera and species. References to this body of literature have been included wherever they have seemed pertinent.

A few species the knowledge of whose occurrence in our area rests upon unverified statement, have been grouped in a separate list which will appear at the end of the paper.

The catalogue must not be regarded as complete in any sense. It has been the writer's purpose simply to bring together in one place as many of the scattered records as possible, so as to make the future direction of botanical work in the Mackenzie basin more intelligent.

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The writer is deeply indebted to a great number of persons and institutions for assistance in preparing this catalogue. The summer journeys of 1928, '29 and '30 in the Wood Buffalo Park were financed entirely by the National Museum of Canada, and the same institution has generously assisted later expeditions by the loan of maps and equipment. The journey to the Peace River and Lake Athabaska in 1932 was supported by the Arnold Arboretum and the National Research Council, while that of 1935 to Lake Athabaska was made possible by a generous grant from the Milton Fund for Research, of Harvard University. Most of the study of earlier collections was accomplished with the aid of fellowship grants from the National Research Council. To the herba-

rium staff of the National Museum of Canada, particularly to the late Dr. M. O. Malte, and to the staff of the New York Botanical Garden Herbarium are due especial thanks for assistance in locating specimens and negotiating large loans of material for study. It is impossible to mention individually all the persons whose friendly guidance and assistance in the field have helped to make long trips more comfortable and collecting more efficient. The author wishes to express his gratitude especially to the officers of the Hudson's Bay Company for innumerable kindnesses rendered over and above the expected services for which remuneration was made. In the determination of specimens, the checking of nomenclature, and the study of ranges, Professor M. L. Fernald of the Gray Herbarium has been a constant source of inspiration and assistance. Mr. C. A. Weatherby has very kindly checked over most of the ferns and fern allies, Dr. Ivan M. Johnston the few specimens of Boraginaceae, and Dr. F. W. Pennell of the Academy of Natural Sciences of Philadelphia has gone over most of the Scrophulariaceae. The specimens of *Arabis* have been examined by Dr. Milton Hopkins of the University of Oklahoma, and those of *Eleocharis* by Dr. H. K. Svensen of the Brooklyn Botanic Garden. Professor Alfred Rehder has given many valued suggestions in the identification of ligneous plants. The determinations of the writer's first two seasons' collections of Gramineae and *Carex* were verified by the late authorities in these groups, Dr. A. S. Hitchcock and K. K. Mackenzie, and his early collections of *Equisetum* were checked by Professor J. H. Schaffner of Ohio State University. The writer's wife, Lucy C. Raup, has been his constant and enthusiastic companion throughout the course of the work, sharing the discomforts and satisfactions of wilderness travel, and contributing notably to the scientific results by her collections and studies of the cryptogamic flora.

OPHIOGLOSSACEAE

Botrychium multifidum (Gmel.) Rupr. — *B. matricariaefolium* (Schrank) Spreng. — *B. ternatum* (Thimb.) Sw. var. *rutaefolium* (A. Br.) D. C. Eat. — See Rept. Mich. Acad. Sci. **18:** 86 (1916). — Apparrently rare, and known from a single locality on the north shore of Lake Athabaska, where it was growing abundantly in sandy thickets and open woods. — Sand Pt., L. Athabaska, nos. 4565, 4649, 4654.

POLYPODIACEAE

Woodsia ilvensis (L.) R. Br. — Common in rock crevices throughout the pre-Cambrian area. — Lake Athabaska: Chipewyan, nos. 4686, 4687, 6050; and *D. G. Revell* [*Moss*, no. 2415(G)]; Shelter Pt., nos. 9, 4434; Sand Pt., nos. 4603, 4611; Charlot Pt., nos. 6097, 6485; W.

shore of Ellis Bay, no. 6109; Cornwall Bay, no. 6455. Granite Hills in Peace R. delta and along upper Slave R., nos. 8, 1450. Great Slave L.: *Howe,* no. 91993(O); near Caribou Isl., *Seton & Preble,* no. 78571-a (O).

Woodsia glabella R. Br. — Apparently confined to moist crevices in dolomitic rocks, mainly in the pre-Cambrian country, where it is common. Plants referred to in Macoun's Catalogue as *Woodsia hyperborea* (*W. alpina*), "Rocks about Fort Chipewyan, Athabaska. (*W. G. Traill*) — northward to the Arctic Circle," may possibly be this species; but the writer has seen no specimen collected by Traill, nor is there any other record for *W. alpina* in the entire Mackenzie basin. — Clearwater R., *J. M. Macoun,* no. 28339(O), and *John Macoun,* no. 28342(O); hills N. of Cornwall Bay, L. Athabaska, nos. 6444, 6498, 6538. Great Slave L.: *R. Bell,* no. 23152(O); Taltheilei Narrows, no. 4; Maufelly Pt., no. 7; Fairchild Pt., nos. 5, 6.

Woodsia oregana D. C. Eat. — Apparently rare, and found thus far only in the Athabaska Lake region where it inhabits moist crevices, chiefly in basic rocks. — Charlot Pt., no. 6434; Cornwall Bay, no. 6435; granite hill in Peace River delta, no. 1453-a.

Woodsia scopulina D. C. Eat. — This record is based upon a single immature specimen collected late in June, 1935, on the north shore of Lake Athabaska. Although somewhat doubtfully determined, due to its fragmentary condition, it bears the characteristic hairs of *W. scopulina,* and is therefore placed here with considerable confidence. — Small island near base of Charlot Pt., no. 6387.

Cystopteris fragilis (L.) Bernh. — *Filix fragilis* (L.) Gilib. — Common in shaded rock crevices, reaching greatest size and abundance in moist ravines. — Clearwater R., *J. M. Macoun,* no. 28471(O). Lake Athabaska: Chipewyan, nos. 4686, 6053; Charlot Pt., nos. 6085, 6234, 6236, 6278; Cornwall Bay, no. 6573. Granite hills in the Peace R. delta, nos. 1453, 4400. Great Slave L.: island in E. arm, no. 3; Taltheilei Narrows, no. 1; Fairchild Pt., no. 2; N. W. shore, *Bedford* (O).

Pteretis nodulosa (Michx.) Nieuwl. — *Onoclea Struthiopteris* of Am. auth., not Hoffm. — *Matteucia Struthiopteris* of Am. auth., not Todaro. — See Rhod. **17:** 164 (1915). — Common in low woods along the lower Clearwater and Athabaska rivers. — Waterways, no. 1449; Reed's Portage, upper Athabaska delta, no. 1448.

Thelypteris Phegopteris (L.) Slosson. — *Phegopteris polypodioides* Fée. — Known in the Mackenzie basin from a single collection, near the eastern end of Lake Athabaska. — Axis L., *Campbell,* no. 132412(O).

Thelypteris Dryopteris (L.) Slosson — *Phegopteris Dryopteris* (L.) Fée. — Although recorded by Richardson at Great Bear Lake, this species has not since been found north of Lake Athabaska. It inhabits rich woods and damp rock crevices. — Clearwater R., *J. M. Macoun,* no. 2841(O); steep slope back of McMurray, no. 7090; along lower Firebag R., no. 6017. Lake Athabaska: Sand Pt., no. 4483; bank of Archibald R. near its mouth, no. 6759.

Thelypteris Robertiana (Hoffm.) Slosson. — *Phegopteris Robertiana* (Hoffm.) A. Br. — *P. Dryopteris* var. *Robertiana* of Macoun's Cat. — Rare or occasional, and found thus far only on the north shore of Lake Athabaska where it inhabits rather dry rock crevices. — Shelter Pt., no. 16; near Sand Pt., no. 4477; Charlot Pt., nos. 6235, 6295; Cornwall Bay, no. 6568.

Thelypteris fragrans (L.) Nieuwl. — *Dryopteris fragrans* (L.) Schott. — *Aspidium fragrans* (L.) Sw. — Common in dry rock crevices in the pre-Cambrian country, usually in exposed situations. — Lake Athabaska: Chipewyan, nos. 6064, 6075; Shelter Pt., no. 13; near Sand Pt., no. 4534; Charlot Pt., no. 6293; near mouth of Charlot R., no. 6331; N. shore of L. Athabaska, *J. W. Tyrrell,* no. 111918(O). Great Slave L.: *R. Bell,* no. 23154(O); near Caribou Isl., *Seton & Preble,* no. 78571(O); Taltheilei Narrows, no. 14; Fairchild Pt., no. 15. Parry Falls, Lochart R., *J. W. Tyrrell,* no. 23144(O).

Thelypteris spinulosa (O. F. Müll.) Nieuwl. — *Dryopteris spinulosa* (O. F. Müll.) Ktze. — *Aspidium spinulosum* (O. F. Müll.) Sw. — Apparently rare, at least in the northern and central parts of the region, and found in damp thickets. Its most northern recorded station is just north of the height of land between Great Slave and Great Bear Lakes (*Bedford,* O). — Near McMurray, no. 7106; Chipewyan, no. 4689.

Pellaea glabella Mett. ex Kuhn. — See Am. Fern. Journ. **7:** 3–5, 77–87 (1917); and **11:** 39–40 (1921). — Apparently quite rare, and although reported by Richardson as far north as Great Bear Lake (as *Pteris atro-purpurea* in Fl. Bor.-Am.), it has never been collected in our region except in the two places cited below. It seems to be confined to limestone or dolomitic rocks. — Clearwater R., *J. M. Macoun,* no. 28389(O) (may possibly be referred to var. *occidentalis* (E. Nels.) Butters [*P. pumila* Rydb.]); crevices in dolomite hill near base of Cornwall Bay, L. Athabaska, no. 6558.

Cryptogramma crispa (L.) R. Br. var. **acrostichoides** (R. Br.) C. B. Clarke. — *C. acrostichoides* R. Br. — See Rhod. **37:** 238–47 (1935). — Common in dry crevices, chiefly on the granitic and older rocks, and reported northward to Great Bear Lake by Richardson. —

Lake Athabaska: Shelter Pt., nos. 17, 4433; N. shore of Ellis Bay, no. 6144; Cornwall Bay, no. 6432. Granite hill along upper Slave R., no. 1451. Great Slave L., *R. Bell,* no. 23153(O).

Polypodium virginianum L. — See Rhod. **24**: 125 (1922). — Common in rock crevices throughout the forested part of the region. — Lake Athabaska: Chipewyan, no. 6065-a; Shelter Pt., no. 12; Sand Pt., no. 4612; Charlot Pt., no. 6095; Fishhook Bay, no. 6589; 5 mi. E. of Poplar Pt., no. 6640. Granite hills in the Peace R. delta and along upper Slave R., nos. 10, 1455, 1456. Great Slave L.: *R. Bell,* no. 23151(O); island in E. arm, no. 11; near Caribou Isl., *Seton & Preble,* no. 78572 (O); 50 mi. N. of Resolution, *J. W. Tyrrell,* no. 23145(O); N. shore, *Bedford* (O).

EQUISETACEAE

Equisetum arvense L. — Common in woods and thickets throughout the region, but occupying a great variety of habitats. — Lower Athabaska R.: about 15 mi. below McMurray, no. 61; Calumet, nos. 49-a, 54; along Firebag R. near its mouth, no. 6045. L. Athabaska: Shelter Pt., nos. 50, 51, 52, 53; Charlot Pt., no. 6264; Cornwall Bay, no. 6506; bank of Archibald R. near its mouth, no. 6756; lake shore just W. of Ennuyeuse Cr., no. 6940. Peace-Athabaska delta and upper Slave R., nos. 55, 56, 57, 58, 62, 66, 1481, 1488; Ft. Smith, no. 63. Great Slave L.: Resolution, *Kennicott* (N); Fairchild Pt., nos. 48, 65, 67, 68, 69, 70, 71, 72; Yellowknife Bay, no. 64; 12 mi. E. of Moraine Pt., N. W. shore, *Bedford* (O).

Equisetum pratense Ehrh. — Not thus far collected north of the Slave River region and the adjacent Wood Buffalo Park, nor eastward in the pre-Cambrian country. In the poplar and poplar-spruce woods of the river flood plains it forms a dense cover on the forest floor, and its early succulent stages are eaten with apparent relish by grazing stock. — Lower Athabaska R.: about 15 mi. below McMurray, no. 46; Calumet, nos. 41, 42. Peace-Athabaska delta and upper Slave R., nos. 44, 45, 47, 1497; Ft. Smith, no. 43.

Equisetum sylvaticum L. var. **pauciramosum** Milde. — See Rhod. **20**: 129 (1918). — Common in rich woods northward to Great Bear Lake (*R. Bell,* O), and extending northeastward beyond the limit of trees (*J. W. Tyrrell,* O). — Lake Athabaska: Shelter Pt., nos. 19, 20, 21; near Sand Pt., no. 4577; Camsell Portage, no. 6202; near Wabba L., N. of Cornwall Bay, no. 6500; Cornwall Bay, no. 6505; 5 mi. E. of Poplar Pt., no. 6698. Great Slave L.: Resolution, *Kennicott* (N); Taltheilei Narrows, no. 18; N. W. shore, *Bedford* (O).

Equisetum palustre L. — Common on low mud bars along the

main rivers. Although Richardson (Fl. Bor.-Am.) reported it as far north as the "shores of the Arctic Sea," the writer has seen no specimens from beyond the Slave River nor from the pre-Cambrian country to the eastward. — Upper Slave R., no. 1470; lower Slave R., below Grande Detour, no. 40.

Equisetum limosum L. — *E. fluviatile* L. — See Rhod. **23:** 43 (1921). — Abundant on the slough margins of lakes and ponds, and on the muddy shores of river flood plains. Not thus far reported north of Great Slave Lake nor beyond the limit of trees. — Calumet, lower Athabaska R., no. 32; lower delta of Athabaska R., no. 33. L. Athabaska: Shelter Pt., no. 34; 5 mi. E. of Poplar Pt., no. 6680; William Pt., no. 6848; about 2 mi. W. of Ennuyeuse Cr., nos. 6967, 6988. Peace R. delta and upper Slave R., nos. 1473, 1478, 1479; Ft. Smith, no. 31; lower Slave R. and delta, nos. 25, 26. Great Slave L.: Fairchild Pt., nos. 27, 28, 30; Yellowknife Bay, no. 29; N. W. shore, *Bedford* (O).

Equisetum prealtum Raf. — *E. robustum* A. Br. — *E. hyemale* L. var. *robustum* (A. Br.) A. A. Eat. — *E. hyemale* L. var. *affine* (Engelm.) A. A. Eat. — Common on the higher parts of mud bars along the main rivers. Not thus far reported north of the Slave River, nor eastward in the pre-Cambrian country. — Athabaska Landing district, *Brinkman,* no. 4061(N); lower Peace R. near its entrance into the Slave, no. 74; upper Slave R., no. 73.

Equisetum scirpoides Michx. — Abundant in timbered muskegs about Great Slave Lake and in the Wood Buffalo Park, but apparently not common farther south. — Charlot Pt., L. Athabaska, no. 6129. Great Slave L.: Fairchild Pt., nos. 22, 24; Yellowknife Bay, no. 23.

Equisetum variegatum Schleich. — Although described as frequent northward to the Arctic in Fl. Bor.-Am., this species appears to be quite rare in that part of the Mackenzie basin south of Great Slave Lake. — Great Slave L.: Taltheilei Narrows, no. 37; Fairchild Pt., nos. 35, 36, 38, 39.

LYCOPODIACEAE

Lycopodium Selago L. — Common in rock crevices about Great Slave Lake, but apparently only occasional in the Athabaska Lake district. Not found thus far in the Paleozoic districts. — Lake Athabaska: Sand Pt., no. 4591; west shore of Ellis Bay, no. 6367; muskeg margin of small pond 5 mi. S. E. of Wolverine Pt., no. 6821. Great Slave L.: *R. Bell,* no. 23150(O); near Caribou Isl., *Seton & Preble,* no. 78573(O); Taltheilei Narrows, no. 86; Maufelly Pt., no. 87.

Lycopodium annotinum L. — This species and its two varieties are common or occasional in woods and thickets northward to Great

Bear Lake. — Lake Athabaska: N. shore, *J. W. Tyrrell,* no. 28285(O); Shelter Pt., nos. 78, 79; Sandy Pt., no. 4513; mouth of Charlot R., no. 6311; Cornwall Bay, no. 6597; 5 mi. E. of Poplar Pt., no. 6673; 2 mi. W. of Ennuyeuse Cr., no. 6938. Great Slave L.: Taltheilei Narrows, no. 80; Pike's Portage, *J. W. Tyrrell,* no. 23146(O).

Lycopodium annotinum L. var. **pungens** Desv. — Shelter Pt., L. Athabaska, no. 75. Great Slave L.: Taltheilei Narrows, no. 76; N. W. shore, *Bedford* (O).

Lycopodium annotinum L. var. **acrifolium** Fern. — See Rhod. **17:** 123 (1915). — Lake Athabaska: Shelter Pt., no. 77; Sand Pt., no. 4590; Camsell Portage, nos. 6187, 6207; Cornwall Bay, no. 6431; sandy woods about 4 mi. S. E. of Wolverine Pt., nos. 6778, 6782.

Lycopodium clavatum L. var. **monostachyon** Grev. & Hook. — See Rhod. **12:** 50 (1910). — Apparently rare in the Mackenzie basin, and collected thus far only on Lake Athabaska. — Shelter Pt., no. 81; Sand Pt., no. 4589; mouth of Archibald R., no. 6755.

Lycopodium clavatum L. var. **megastachyon** Fern. & Bissell. — See Rhod. **12:** 50 (1910). — Apparently quite rare, and known in this region from a single collection. It has been collected also in the Lesser Slave Lake district (*Brinkman,* N) but nowhere else in the Mackenzie basin. — Rocky lake shore at Shelter Pt., L. Athabaska, no. 82.

Lycopodium obscurum L. var. **dendroideum** (Michx.) D. C. Eat. — See Rhod. **23:** 188 (1921). — Rare or occasional in the northern part of the Mackenzie basin, but common in the sandy woodlands about Lake Athabaska, particularly on the south side. It has not been collected on Great Slave Lake, but has been found near Ft. Norman, on the Mackenzie River (*Miss E. Taylor,* O). — McMurray, no. 7120. Lake Athabaska: near Sand Pt., no. 4592; Camsell Portage, no. 6188; N. of Cornwall Bay, no. 6512; 5 mi. E. of Poplar Pt., no. 6646; point about 4 mi. E. of Wolverine Pt., no. 6806; William Pt., no. 6899.

Lycopodium sabinaefolium Willd. var. **sitchense** (Rupr.) Fern. — *L. sitchense* Rupr. — See Rhod. **25:** 166 (1923). — Apparently rare, and known only from the following two localities. The only other record for the Mackenzie basin is from Lesser Slave Lake (*Brinkman,* N). — Portage la Loche (Methye Portage), *John Macoun,* no. 28199(O) (under *L. sabinaefolium* in Macoun's Cat.); sandy woods along William R. near its entrance to L. Athabaska, no. 6898.

Lycopodium complanatum L. — Common in dry woods northward to Great Bear Lake. A form with very short peduncles (1 cm. or less) is common about Lake Athabaska. It is represented by nos. 6399, 6647, 6803. — Lake Athabaska: Shelter Pt., nos. 84, 85; Sand Pt., no.

4588; Charlot Pt., no. 6399; Cornwall Bay, no. 6592; 5 mi. E. of Poplar Pt., no. 6647; point about 4 mi. E. of Wolverine Pt., no. 6803. Great Slave L.: Taltheilei Narrows, no. 83; Ft. Reliance, *J. W. Tyrrell,* no. 23147(O).

Lycopodium tristachyum Pursh. — Occasional in sandy thickets and open woods about Lake Athabaska. — Sand Pt., no. 4587; Camsell Portage, no. 6211; just E. of Wolverine Pt., no. 6797.

SELAGINELLACEAE

Selaginella selaginoides (L.) Link. — Known thus far in the Mackenzie basin east of the mountains only from the following station. — Wet mossy crevices on shore of L. Athabaska near Sand Pt., no. 4629.

Selaginella rupestris (L.) Spring. — Common on exposed rocky and sandy hillsides about Lake Athabaska, but unknown elsewhere in the Mackenzie basin. — Shelter Pt., no. 4451; Sand Pt., no. 4608; Charlot Pt., nos. 6305, 6411; Cornwall Bay, no. 6607; near mouth of Ennuyeuse Cr., no. 6929.

ISOËTACEAE

Isoëtes Braunii Dur. — See Ann. Mo. Bot. Gard. **9:** 156–73 (1922). — Apparently quite rare, and known in the Mackenzie basin from a single collection. — In shallow water on the sandy-gravelly shore of a small lake near Sand Pt., L. Athabaska, no. 4617.

PINACEAE

Picea glauca (Moench) Voss. — *P. canadensis* of most Am. auth. — *P. alba* of Macoun's Cat. — *Pinus alba* of Fl. Bor.-Am. — See Rhod. **17:** 60–2 (1915). — The predominating forest tree throughout most of the Mackenzie basin, extending nearly to the arctic coast and far out into the Barren Lands in sheltered places. It reaches its best development on the banks of the main rivers and on the better-drained soils of the uplands, particularly in the Paleozoic and younger regions. 75-ft. trees, 2 feet in diameter at the base, are common in the lowlands, while larger ones, 3 ft. or more in diameter, occur in localized areas. In exposed places, particularly eastward in the pre-Cambrian country, the trees become much dwarfed, with gnarled and twisted trunks and branches. On sand plains about Great Slave Lake the spruce forms an open park-like forest of comparatively small but straight trees, while on Lake Athabaska its place is largely taken by *Pinus Banksiana* in such situations. — Calumet, lower Athabaska R., nos. 97, 98; Lake Athabaska: N. shore, *J. W. Tyrrell,* no. 25039(O); Shelter Pt., no. 99; near Sand Pt., nos. 4541, 4662; Charlot Pt., no. 6401; 2 mi. W. of

Ennuyeuse Cr., no. 6954. Peace R. delta and upper Slave R., nos. 102, 103, 1526; Ft. Smith, no. 100. Great Slave L.: Taltheilei Narrows, no. 104; Fairchild Pt., nos. 101, 105, 106. Artillery L., *J. W. Tyrrell,* no. 23134(O).

Picea mariana (Mill.) B. S. P. — *Pinus nigra* of Fl. Bor.-Am. — *Picea nigra* of Macoun's Cat. — The most abundant tree in the muskeg timber of the central part of the Mackenzie basin. It is rarely observed more than 5 or 6 inches in diameter, and is usually much smaller than this. In the pre-Cambrian region it is sometimes associated with white birch and jack pine on sand plains. Richardson placed its northern boundary at lat. 65°, but the writer has seen no specimens from north of Great Slave Lake. Preble reported it on the north slopes of the Nahanni Mountains, west of the Mackenzie. — Calumet, lower Athabaska R., no. 95. Lake Athabaska: N. shore, *J. W. Tyrrell,* no. 25074(O); Shelter Pt., nos. 91, 92, 93, 94; near Sand Pt., no. 4664; Charlot Pt., no. 6400; about 2 mi. W. of Ennuyeuse Cr., no. 7008. Fairchild Pt., Great Slave L., no. 96.

Abies balsamea (L.) Mill. — This species is common only in the southern and southeastern parts of the Mackenzie basin, and its northern boundary is still conjectural. Richardson (Bot. App. to Franklin's first exped.) states that he found it at latitude 62°, but is not specific as to locality. Dr. Charles Camsell, exploring for the Canadian Geological Survey west of Fort Smith in 1902, reported finding the balsam fir in the gorge of the Little Buffalo River (C. G. S. Ann. Rept. **15:** 159A), but this has not been verified. The farthest north from which the writer has seen specimens is the delta of the Athabaska River, and this is consistent also with the findings of Preble (N. Am. Fauna, No. 27, p. 518). — Reed's Portage, Athabaska R. delta, no. 1521.

Larix laricina (DuRoi) Koch. — *L. americana* Michx. — This species probably extends through the entire timbered part of the Mackenzie basin, although actual specimens of it from the far north are rare in herbaria. It is common in muskegs in the Athabaska — Great Slave Lake region, but it nearly always plays a secondary part in the timber, and rarely exceeds 8–10 inches in diameter. — Lake Athabaska: Shelter Pt., nos. 88, 89; near Sand Pt., no. 4663; mouth of Charlot R., no. 6317; about 2 mi. W. of Ennuyeuse Cr., no. 7007. Great Slave L.: Taltheilei Narrows, no. 90; N. W. shore, *Bedford* (O).

Pinus Banksiana Lamb. — *P. divaricata* of auth. — Abundant on dry sand plains and on sandy and rocky hills northward through the central part of the timbered country. About Lake Athabaska and west of the Slave River it is the characteristic species of large tracts of park-

like timber in which there is but little undergrowth and a very sparse ground cover. Richardson reported it on the sandy banks of the Mackenzie beyond lat. 64°. On the eastern arm of Great Slave Lake it is displaced on the sand plains by white spruce, *Picea glauca,* but occurs in scattered localities nearly to the limit of trees. — Calumet, lower Athabaska R., no. 107. Lake Athabaska: Goose Isl., *Laing,* no. 22(N); Shelter Pt., nos. 108, 109; Sand Pt., no. 4653; west shore of Ellis Bay, no. 6169; 2 mi. W. of Ennuyeuse Cr., no. 6953. Great Slave L.: Pike's Portage, *J. W. Tyrrell,* no. 23135(O); N. W. shore, *Bedford* (O).

Juniperus communis L. var. **montana** Ait. — *J. sibirica* Burgsd. — Common throughout the region on dry rocky and sandy plains and ridges. — Lake Athabaska: Shelter Pt., nos. 110, 111, 112, 113; Sand Pt., no. 4661; Charlot Pt., no. 6144; Cornwall Bay, no. 6602; sandy bank of Archibald R., near its mouth, no. 6734; 2 mi. W. of Ennuyeuse Cr., no. 6932. Granite hill along upper Slave R., no. 1516. Great Slave L.: Taltheilei Narrows, no. 117; Fairchild Pt., nos. 114, 116; Ft. Reliance, no. 115; S. W. and N. shores, *Howe,* no. 91992(O).

Juniperus horizontalis Moench. — *Sabina horizontalis* (Moench.) Rydb. — Common in dry sandy and rocky places throughout the timbered country northward at least to the Great Slave Lake region. — Lake Athabaska: Chipewyan, *Laing,* no. 23(N), and *J. W. Tyrrell,* no. 24952(O); Shelter Pt., nos. 119, 120; granite island about 6 mi. E. of Chipewyan, no. 4671; Charlot Pt., no. 6141; Cornwall Bay, no. 6603. Ft. Smith, no. 121. Great Slave L.: Caribou Isl., *Seton & Preble,* no. 78568(O); Taltheilei Narrows, no. 125; Fairchild Pt., nos. 122, 123, 124.

TYPHACEAE

Typha latifolia L. — Richardson reported this species as far north as Ft. Franklin (Fl. Bor.-Am.), but the writer has seen no specimens from beyond the Wood Buffalo Park region, where it is common on the shores of lakes and ponds. Also it has not been noted anywhere in the pre-Cambrian region to the eastward. — Lower delta of Athabaska R., nos. 126, 1530; upper Slave R. lowlands, no. 1533.

SPARGANIACEAE

Sparganium eurycarpum Engelm. — See Rhod. **24:** 26 (1922). — Common at the margins of ponds and slow streams in the Athabaska-Peace delta, but not elsewhere reported in the Mackenzie basin. — Lower delta of Athabaska R. (Mamawi Cr.), no. 1540; upper Slave R. lowlands, nos. 128, 1541.

Sparganium multipedunculatum (Morong) Rydb. — See Rhod. **27:** 190 (1925). — The commonest bur-reed in the central part of

forested region, but scarcely extending eastward into the pre-Cambrian country. It is most abundant at the margins of lakes, sloughs, and slow streams, and has been noted as far northward as Ft. Franklin (*Richardson,* N). — Lower delta of Athabaska R. (Mamawi Cr.), no. 1535; Chipewyan, no. 4693; upper Slave R. lowlands, no. 1536. Great Slave L.: Buffalo R., *Richardson* (G) (under *S. simplex* in Fl. Bor.-Am. and Macoun's Cat.); N. W. shore, *Bedford* (O).

Sparganium fluctuans (Morong) B. L. Robinson. — Known in the Mackenzie basin from only two localities about Lake Athabaska. — Small pond at Shelter Pt., no. 127; small lagoon near shore of main lake about 2 mi. west of Ennuyeuse Cr., no. 6992.

Sparganium angustifolium Michx. — See Rhod. **24:** 26 (1922). — Locally abundant in ponds and slow streams, and not yet noted north of Great Slave Lake. — Lake Athabaska: pond near base of Cornwall Bay, no. 6616; pond about 2 mi. W. of Ennuyeuse Cr., no. 6990. Upper Slave R. lowland, no. 1544. Great Slave L.: Fairchild Pt., no. 130; Ft. Rae, *Bedford* (O).

Sparganium minimum Fries. — Common at muskeg or pond margins about Lake Athabaska, but very little collected elsewhere in the Mackenzie basin, though it is probably widespread. — Lake Athabaska: Shelter Pt., no. 4423; small pond near base of Cornwall Bay, no. 6615; William Pt., nos. 6843, 6865; small lagoon about 2 mi. W. of Ennuyeuse Cr., no. 6997.

POTAMOGETONACEAE

Potamogeton tenuifolius Raf. — *P. alpinus* of Am. auth. — See Rhod. **32:** 76–83 (1930) and **33:** 209–11 (1931). — Common in ponds and slow streams about Lake Athabaska, but very little collected elsewhere in the Mackenzie basin, though it is probably widespread. — Lake Athabaska: small ponds near base of Cornwall Bay, nos. 6498-a, 6618, 6621, 6622; Archibald R. near its mouth, nos. 6741, 6742; no. 6742 was growing in more rapid water, and has the form of var. *subellipticus* (Fern.) Fern.

Potamogeton gramineus L. var. **graminifolius** Fries. — *P. heterophyllus* of most recent Am. auth., not Schreb. — See Rhod. **23:** 189 (1921). — Apparently common in shallow lakes and slough ponds throughout the forested region northward to Great Bear Lake (*Porsild,* G). It is abundant in the lower deltas of the Athabaska and Peace Rivers. — Lake Athabaska: Shelter Pt., no. 136; near Sand Pt., no. 4614; small pond about 5 mi. S. E. of Wolverine Pt., no. 6823; William Pt., no. 6849; small lagoon about 2 mi. W. of Ennuyeuse Cr., no. 7002. Lake Mamawi, no. 1548; upper Slave R. lowlands, nos. 135, 1546. Northwest shore of Great Slave L., *Bedford* (O).

Potamogeton Richardsonii (A. Benn.) Rydb. — This is probably the commonest pondweed in the region, and is abundant in shallow lakes and slough ponds throughout the forested parts north to Great Bear Lake (*Porsild,* G). It is associated with *P. vaginatus* in the great masses of weed which clog the shallow expanses of Lakes Claire and Mamawi, and the western part of Lake Athabaska. — Methye Portage, *J. M. Macoun,* no. 3047(O) (*P. perfoliatus* var. *Richardsonii* of Macoun's Cat.). Lake Athabaska: about 6 mi. E. of Chipewyan, no. 4666; Charlot R. near its mouth, no. 6352; small ponds near base of Cornwall Bay, nos. 6497-a. no. 6617. Lake Mamawi, no. 1551; upper Slave R. lowland, nos. 134, 1556. Great Slave L.: N. W. shore, *Bedford* (O); Ft. Rae, *Bedford* (O).

Potamogeton praelongus Wulf. — Probably common throughout the forested region, but very little collected. It inhabits the deeper water off-shore in relatively shallow lakes, and has been found in Arctic Mackenzie by the Porsild brothers. It is apparently common in the Wood Buffalo Park. — Yellowknife Bay, Great Slave L., no. 133.

Potamogeton zosteriformis Fern. — See Mem. Gray Hb. **3:** 36–40 (1932). — Found in the Mackenzie basin thus far only in the Wood Buffalo Park, where it grows in shallow, marshy lakes both on the upland and the Slave River lowland. — Slave River lowland (Murdock Cr.), no. 1565.

Potamogeton foliosus Raf. var. **macellus** Fern. — See Mem. Gray Hb. **3:** 46–51 (1932). — Known in this region in the Slave River area, and noted also farther west in the Wood Buffalo Park and southward. It grows in shallow lakes and ponds. — Upper Slave R. lowlands, no. 132.

Potamogeton Friesii Rupr. — Probably common in shallow lakes and slough ponds though very little collected, and known northward to Great Bear Lake (*Porsild,* G). In our region it is not recorded east of the Slave River district. — Upper Slave R. lowlands (Murdock Cr. district), no. 1564.

Potamogeton obtusifolius Mert. & Koch. — Known from a single collection near the north shore of Lake Athabaska, and found there only in sterile condition. — Small pond near base of Cornwall Bay, no. 6632.

Potamogeton pusillus L. var. **polyphyllus** Morong. — Collected thus far only once in the Mackenzie basin, in the Athabaska delta. — Lower Athabaska R. delta (Mamawi Cr.), no. 1569.

Potamogeton pusillus L. var. **mucronatus** (Fieber) Graebn. — Known in the Mackenzie basin only from the country about Lake Atha-

baska, where it inhabits streams and ponds. — Small pond near base of Cornwall Bay, no. 6633; Archibald R. near its mouth, no. 6751.

Potamogeton filiformis Pers. var. **borealis** (Raf.) St. John. — See Rhod. **18**: 134 (1916). — Probably common throughout, though not much collected in the pre-Cambrian regions. It is most abundant on the sandy bottoms of shallow lake margins. — Near Sand Pt., L. Athabaska, nos. 4615, 4616. Great Slave L.: Fairchild Pt., no. 131; N. W. shore, *Bedford* (O).

Potamogeton vaginatus Turcz. — See Rhod. **18**: 131 (1916) and **20**: 191 (1918). — Although very little collected, this species shows a wide range northward to Great Bear Lake (*Porsild,* G). It has not been found eastward in the pre-Cambrian region about Athabaska and Great Slave Lakes, but is abundant in the shallow water of the Athabaska-Peace delta where, with *P. Richardsonii,* it forms most of the large patches of weed. — Lake Mamawi, no. 1549.

Potamogeton pectinatus L. — Probably common, at least south of Great Slave Lake, in shallow lakes which have sand or gravel bottoms. — Lake Athabaska: about 6 mi. E. of Chipewyan, no. 4667; small pond near base of Cornwall Bay, nos. 6619, 6634.

SCHEUCHZERIACEAE

Triglochin maritima L. — Common in semi-saline muskegs, sloughs, and wet prairies northward through the Paleozoic and younger country to the basin of Great Bear Lake (*Bedford,* O), and occasional eastward in the pre-Cambrian. In the latter it appears to prefer areas of dolomitic rocks, but also occurs in the sandy country south of Lake Athabaska. — Lake Athabaska: near mouth of Charlot R., no. 6343; about 3 mi. W. of Ennuyeuse Cr., no. 6973. Upper Slave R. lowland, no. 1586. Great Slave L.: Keith Isl., no. 137; Fairchild Pt., nos. 138, 139.

Triglochin palustris L. — Known in the pre-Cambrian region only on Great Slave Lake, but occasional in the Wood Buffalo Park. — Keith Isl., eastern arm of Great Slave L., no. 140.

Scheuchzeria palustris L. — See Rhod. **25**: 177–9 (1923). — Known thus far in the Mackenzie basin only from shallow pond margins on the south side of Lake Athabaska, where it is abundant. — William Pt., no. 6868; about 3 mi. W. of Ennuyeuse Cr., no. 6962.

ALISMACEAE

Saggitaria cuneata Sheldon. — *S. arifolia* Nutt. — Common at the margins of ponds and slow streams in the southern part of the Mackenzie basin, and extending to Great Slave Lake in the Paleozoic

country. It was noted by Harper east of the mouth of the Taltson River. — Lower delta of Athabaska R., nos. 393, 1587; upper Slave R. lowland, nos. 1589, 1591; N. W. shore of Great Slave L., *Bedford* (O).

Alisma Plantago-aquatica L. subsp. **brevipes** (Greene) Samuels. — See Arkiv för Botanik, **24**, 7:19–21 (1932). — Known in this region only in a damp slough at Chipewyan. It also occurs in the Lesser Slave Lake region (*Brinkman*, N). — Chipewyan, no. 4692.

GRAMINEAE

Bromus ciliatus L. — Common in the Paleozoic country northward to the lower Mackenzie, in prairies and other open ground, but not found thus far in the pre-Cambrian regions. — Lower Athabaska R., *Kennicott* (N); McMurray, no. 7101; Ft. Resolution, *Kennicott* (N).

Bromus Pumpellianus Scribn. — Abundant on the sandy beaches and dunes about Lake Athabaska, and at least occasional northward to Great Bear Lake and the Arctic coast (*Richardson*, G, N). It is also widespread in the Wood Buffalo Park and southwestward. — Lake Athabaska: *Laing*, no. 223 (G); Shelter Pt., nos. 205, 206; Sand Pt., no. 4571; 2 mi. E. of Wolverine Pt., no. 6721; shifting sand dunes just E. of Ennuyeuse Cr., no. 6911 (form with very hirsute sheaths). Ft. Smith, no. 204.

Festuca brachyphylla Schultes. — See Rhod. **37**: 250–2 (1935). — An arctic and alpine species known in this region only on the north shore of Lake Athabaska, where it is found in rock crevices. — Small island about 2 mi. E. of Crackingstone Pt., no. 6423.

Festuca rubra L. — See Rhod. **35**: 132–5 (1933). — Apparently occasional in the sandy country south of Lake Athabaska, but not known elsewhere in the Mackenzie basin except at Great Bear Lake (*J. M. Bell*, O). — Lake Athabaska: lake shore about 2 mi. E. of Wolverine Pt., no. 6723-a; shifting sand dunes 5 mi. S. of William Pt., no. 6905; sand dunes 2 mi. W. of Ennuyeuse Cr., no. 6941-a.

Festuca rubra L. var. **arenaria** (Osbeck) Fries. — See Rhod. **35**: 132–5 (1933). — Like the last, this is abundant on sand beaches and dunes about Lake Athabaska, and recurs at Great Bear Lake and on the Arctic coast (*Richardson*, G). Of the following specimens, nos. 6894 and 6900 represent a proliferous form of var. *arenaria*. — Shelter Pt., nos. 171, 4432; Sand Pt., no. 4573; lake shore about 2 mi. E. of Wolverine Pt., nos. 6713, 6723; shifting dunes 5 mi. S. of William Pt., no. 6894; beach at William Pt., no. 6900; sand dunes 2 mi. W. of Ennuyeuse Cr., no. 6941.

Festuca saximontana Rydb. — See Rhod. **37**: 250–2 (1935). — Common on dry prairies, ridges and beaches northward to Great Bear

Lake (*Richardson*, G, N). — Lake Athabaska: Shelter Pt., nos. 165, 166, 167; Sand Pt., no. 4498; Charlot Pt., nos. 6100, 6257, 6391; N. shore of Ellis Bay, nos. 6117, 6118; sandy beach on main lake shore west of Ellis Bay, no. 6271; rocky point at N. W. entrance to Black Bay, no. 6415; near Wabba L., N. of Cornwall Bay, no. 6467; Cornwall Bay, nos. 6508, 6523, 6544, 6611; 5 mi. E. of Poplar Pt., nos. 6648, 6654; sand ridges about 4 mi. S. E. of Wolverine Pt., no. 6789; gravel dunes just E. of Ennuyeuse Cr., no. 6923; 2 mi. W. of Ennuyeuse Cr., nos. 6939, 6983. East shore of L. Mamawi, no. 1669; Ft. Smith, no. 168; Ft. Reliance, Great Slave L., nos. 169, 170.

Fluminia festucacea (Willd.) Hitchc. — *Scolochloa festucacea* (Willd.) Link. — *Festuca borealis* Mert. & Koch. — Common at lake margins and in wet meadows northward in the Paleozoic and younger country at least to the Wood Buffalo Park, but not known eastward of the great river lowlands. — Lower Athabaska R. delta (Mamawi Cr.), no. 1601; E. shore of L. Mamawi, nos. 1600, 4418; upper Slave R. lowlands, nos. 1599, 1604.

Glyceria striata (Lam.) Hitch. var. **stricta** (Scribn.) Fern. — *Panicularia nervata* (Willd.) Ktze. var. *stricta* Scribn. — *P. rigida* (Nash) Rydb. — See Proc. Biol. Soc. Wash. **41:** 157 (1928) and Rhod. **31:** 47 (1929). — Not known north of the Athabaska region, where it grows in damp woods. The specimens from Reed's Portage are very mature, and may represent the species rather than the variety. They were so cited in the writer's *Bot. Investigations in the Wood Buffalo Park*. — Upper Athabaska delta (Reed's Portage), no. 1620; thicket near base of Cornwall Bay, L. Athabaska, no. 6503.

Glyceria grandis Wats. — *Panicularia grandis* Nash. — Common in wet meadows of the great river lowlands north to Great Slave Lake. — Upper Slave R. lowlands, nos. 1610, 1616; Resolution, *Kennicott* (N).

Glyceria pulchella (Nash) K. Sch. — *Panicularia pulchella* Nash. — Common in the wetter parts of sloughs northward to Lake Athabaska and the Wood Buffalo Park. — Lower delta of Athabaska R., no. 200. Lake Athabaska: Shelter Pt., no. 201; 5 mi. E. of Poplar Pt., no. 6675. Upper Slave R. lowland, no. 1611.

Glyceria borealis (Nash) Batchelder. — *Panicularia borealis* Nash. — Found occasionally in wet sloughs in the central parts of the Mackenzie basin, and probably northward in the forested areas. — Lower delta of Athabaska R., no. 202. Lake Athabaska: Shelter Pt., no. 203; 2 mi. W. of Ennuyeuse Cr., no. 6995. Upper Slave R. lowland, no. 1618.

Puccinellia Nuttalliana (Nutt.) Wats. & Coult. — *P. airoides*

(Schultes) Hitchc. — Probably common throughout the forested region in semi-saline situations, but not known eastward in the pre-Cambrian region. — Lower delta of Athabaska R., no. 199. Great Slave L.: *Richardson* (G) (*Poa airoides* in Fl. Bor.-Am., and *Glyceria airoides* in Macoun's Cat.); S. W. and N. shores, *Howe,* no. 91994(O).

Poa alpina L. — Although noted in Fl. Bor.-Am. as ranging "to Bear Lake and the Rocky Mountains," this species has been collected in the Mackenzie basin east of the Rockies only in the more arctic areas toward the limit of trees. — Charlot Pt., L. Athabaska, no. 6383; Ft. Reliance, Great Slave L., no. 141.

Poa pratensis L. — Common in damp meadows, prairies, and open woods throughout the forested region, with records at least as far northward as Great Bear Lake (*Richardson,* N; *J. M. Bell,* O). — Clearwater R., Sask., *J. M. Macoun,* no. 101824(O); Calumet, Athabaska R., no. 151. Lake Athabaska: Sand Pt., no. 4572; near mouth of Charlot R., nos. 6322, 6339; 5 mi. E. of Poplar Pt., no. 6679; point about 4 mi. E. of Wolverine Pt., no. 6808. Granite hill on E. shore of L. Mamawi, no. 1715; upper Slave R. lowlands, nos. 146, 1717, 1721, 1726; Ft. Smith, nos. 149, 152. Great Slave L.: Fairchild Pt., nos. 148, 150, 153; Ft. Reliance, no. 147.

Poa lanata Scribn. & Merrill. — An Alaskan species known in the Mackenzie basin from a single collection south of Lake Athabaska, where it was found infrequently on partially fixed sand dunes. — Shifting sand dunes just E. of Ennuyeuse Cr., no. 6916.

Poa compressa L. — Known in the Mackenzie basin only from the following collection. It is probably introduced. — Fort Smith, no. 142.

Poa palustris L. — *P. triflora* of auth. — See Rhod. **18**: 235 (1916). — Common in sloughs and on damp shores northward to the Wood Buffalo Park, but apparently extending only a short distance eastward into the pre-Cambrian. — McMurray, no. 7095; Calumet, Athabaska R., no. 151; lower delta of Athabaska R., nos. 143, 144; Shelter Pt., L. Athabaska, no. 145; E. shore of L. Mamawi, nos. 1707, 1710; Ft. Smith, nos. 151, 152.

Poa glauca L. — Common on dry sandy shores and ridges, and in dry crevices on rocky hills throughout the forested region. Although no specimens are available from beyond the timber line it is probably to be found there also since it is a wide-ranging arctic species. — Clearwater R., Sask., *J. M. Macoun,* no. 29217(O); Calumet, Athabaska R., no. 154. Lake Athabaska: Chipewyan, nos. 6045, 7021; Shelter Pt., nos. 4460, 4461; Sand Pt., nos. 4494, 4502, 4602; Charlot Pt., nos. 6091, 6092, 6098, 6099, 6137, 6253, 6256, 6277, 6392, 6393, 6394, 6408; N.

shore of Ellis Bay, nos. 6112, 6125; shore of main lake just W. of Ellis Bay, no. 6270; rocky point at N. W. entrance to Black Bay, no. 6416; hill south of Wabba L., no. 6469; base of Cornwall Bay, nos. 6507, 6543; 5 mi. E. of Poplar Pt., no. 6644. East shore of L. Mamawi, nos. 1745, 1746, 1747; granite hills in upper Slave R. lowlands, no. 1743; Ft. Smith, no. 160; Cassette Portage, Slave R., *Kennicott* (N); island at east end of Black L., lat. 60°, *Harper,* no. 90049(O). Great Slave L.: Resolution, *Onion, Kennicott & Hardisty* (N); island at mouth of Rocher R., *Harper,* no. 90048(O); Taltheilei Narrows, nos. 155, 158; Fairchild Pt., nos. 156, 157, 161; Maufelly Pt., no. 159; Ft. Reliance, nos. 162, 163, 164.

Poa arida Vasey. — Found thus far only in the drier parts of semi-open prairies west of the Slave River, in the Wood Buffalo Park.

Poa glaucifolia Scribn. & Williams. — This appears to be a prairie species which has been found in our region only on a patch of clayey soil on a granite hill in the Athabaska-Peace delta. — East shore of L. Mamawi, no. 1748.

Poa Buckleyana Nash. — Found growing abundantly on a hill-side of conglomerate rock on the north shore of Lake Athabaska, but not known elsewhere in the Mackenzie basin. — Charlot Pt., nos. 6255, 6289, 6410.

Distichlis stricta (Torr.) Rydb. — See Rhod. **27:** 67 (1925). — Known in this region only on the Salt Plains west of the upper Slave River.

Phragmites communis Trin. var. **Berlandieri** (Fournier) Fern. — See Rhod. **34:** 211 (1932). — Collected thus far only about the western end of Lake Athabaska, but probably common on river and lake shores in the southern part of the basin. — Lower delta of the Athabaska R., no. 1706; mouth of Athabaska R., *Harper,* no. 90061(O); shore of small lake near Sand Pt., L. Athabaska, no. 4604.

Schizachne purpurascens (Torr.) Swallen. — *Avena striata* Michx. — *Bromelica striata* (Michx.) Farwell. — *Melica purpurascens* (Torr.) Hitch. — See Jour. Wash. Acad. Sci. **18:** 203 (1928). — Common in prairies and open woods northward to Lake Athabaska and the Wood Buffalo Park. — Clearwater R., Sask., *J. M. Macoun,* no. 30087(O); Calumet, Athabaska R., no. 192. Athabaska L.: west shore of Ellis Bay, no. 6168; Charlot Pt., no. 6407; Cornwall Bay, no. 6438.

Agropyron Smithii Rydb. var. **molle** (Scribn. & Sm.) Jones. — Collected thus far only on the drier part of a prairie at Peace Point in the Wood Buffalo Park.

Agropyron trachycaulum (Link) Malte var. **typicum** Fern. — *A.*

tenerum Vasey. — See Rhod. **35:** 161–82 (1923) and **36:** 417 (1934), also Ann. Rept. Nat. Mus. Can. for 1930, pp. 27–48 (1932) for treatments of this and the following. — Common in open woods, prairies, the drier parts of meadow sloughs, and on sandy lake beaches in the central and southern parts of the Mackenzie basin. It is known on the Mackenzie as far northwest as Ft. Norman (*Richardson,* G), but has not been recorded beyond the limit of trees. — Below Pelican Rapids, Athabaska R., *Harper,* no. 90057(O). Lake Athabaska: Cornwall Bay, no. 6443; hills south of Wabba L., no. 6473; cabin clearing about 3 mi. W. of Ennuyeuse Cr., no. 6956. East shore of L. Mamawi, nos. 1818, 1819; upper Slave R. lowlands, nos. 1810, 1811; Slave R., *Richardson* (G) (*Triticum caninum* of Fl. Bor.-Am., in part); Resolution, *Kennicott* (N).

Agropyron trachycaulum (Link) Malte var. **unilaterale** (Cassidy) Malte. — *A. Richardsonii Schrad.* — Common in upland prairies and the drier parts of meadow sloughs, with a range similar to the last. In the pre-Cambrian country it grows on sandy beaches and in small deposits of soil on the granite hills. — Lake Athabaska: Chipewyan, no. 4694; Shelter Pt., no. 179; Cornwall Bay, no. 6553. Upper Slave R. lowlands, nos. 1797, 1798.

Agropyron latiglume (Scribn. & Sm.) Rydb. — *A. caninum* (L.) R. & S. var. *latiglume* (Scribn. & Sm.) Pease & Moore. — *A. violaceum* (Hornem.) Lange var. *latiglume* Scribn. & Sm. — *A. biflorum* (Brign.) R. & S. var. *latiglume* (Scribn. & Sm.) Piper. — See Rhod. **35:** 169 (1933), and Ann. Rept. Nat. Mus. Can. for 1930, pp. 27–48 (1932). — An arctic species probably extending south of the timber line locally in many places, but very little collected. Known also at Great Bear L. (*Richardson,* G; *J. M. Bell,* O). — Fort Reliance, Great Slave L., no. 180.

Arctophila fulva (Trin.) Rupr. — *Colpodium fulvum* (Trin.) Griseb. — See Rept. Can. Arct. Exped. **5:** 6B (1922). — An arctic species known thus far in the Mackenzie basin from a single collection on the south shore of Great Slave Lake. — Black Bay, E. of mouth of Rocher R., Great Slave L., *Harper,* no. 90051(O).

Elymus canadensis L. — *E. robustus* Scribn. & Sm. var. *vestitus* Wieg. — See Rhod. **35:** 187–98 (1933). — Occasional in the central part of the Mackenzie basin northward to Great Slave Lake, but not known in the pre-Cambrian country. — McMurray, no. 7072; Great Slave L., *Richardson* (G).

Elymus Macounii Vasey. — Known in this region only in the Salt River country, west of the upper Slave River.

Elymus innovatus Beal. — A common grass of dry woods, prairies and shores, extending northward to Great Bear Lake (*Richardson,* G) but apparently only occasional in the pre-Cambrian regions. — Methye Portage, Sask., *J. M. Macoun,* nos. 81134, 29780(O); Calumet, Athabaska R., no. 184; upper Slave R. lowland, nos. 1651, 1658. Ft. Smith, nos. 183, 185; Maufelly Pt., Great Slave L., no. 182.

Elymus arenarius L. var. **villosus** E. Mey. — See Rhod. **17**: 98–103 (1915). — Common or abundant on sand beaches and dunes about the larger lakes. — Lake Athabaska: Shelter Pt., nos. 181, 4421; Sand Pt., no. 4575; shore of main lake just W. of Ellis Bay, no. 6269; 2 mi. E. of Wolverine Pt., no. 6717; shifting dunes just E. of Ennuyeuse Cr., no. 6915; E. end of L. Athabaska, *J. W. Tyrrell,* no. 29826(O). Great Slave L.: S. W. and N. shores, *Howe,* no. 91989(O); N. W. shore, *Bedford* (O).

Hordeum jubatum L. — Common on dry sandy shores, prairies, and in cabin clearings throughout the central and southern parts of the Mackenzie basin, but only occasional eastward in the pre-Cambrian areas. Noted on the Mackenzie by Richardson. — Lake Athabaska: Shelter Pt., no. 193; 3 mi. W. of Ennuyeuse Cr., no. 6957. East shore of L. Mamawi, no. 1630; Resolution, *Harper,* no. 90056(O).

HORDEUM VULGARE L. — Barley is cultivated successfully as far northward as Aklavik, in the Mackenzie delta, and is occasionally seen about settlements and cabin clearings as an escape. — Upper Slave R. lowland (Government Hay Camp), no. 1635.

Koeleria cristata (L.) Pers. — Common on dry prairies and bluffs west of the upper Slave River.

Trisetum spicatum (L.) Richter var. **molle** (Michx.) Beal. — *T. subspicatum* (L.) Beauv. var. *molle* Gray. — See Rhod. **18**: 195 (1916), and **30**: 239 (1928). — Common on sandy beaches or in damp shore rock crevices throughout the pre-Cambrian country and northward to Great Bear Lake (*Richardson,* G, N; *J. M. Bell,* O). Occasional in the Paleozoic regions. — Lake Athabaska: Shelter Pt., nos. 174, 4457; Sand Pt., nos. 4503, 4504; Charlot Pt., nos. 6131, 6249, 6389; W. shore of Ellis Bay, no. 6374; shore of main lake just W. of Ellis Bay, no. 6272; rocky point at N. W. entrance to Black Bay, nos. 6417, 6421; Cornwall Bay, no. 6545; 5 mi. E. of Poplar Pt., no. 6653. Great Slave L.: Keith Isl., no. 175; Fairchild Pt., no. 176.

Sphenopholis pallens (Spreng.) Scribn. — Occasional on sandy shores of lakes and streams in the Wood Buffalo Park.

Avena Hookeri Scribn. — Found thus far only on the drier parts of a prairie at Peace Point, in the Wood Buffalo Park.

AVENA FATUA L. var. GLABRATA Peterm. — Found in this region only as an introduced weed in cabin clearings. — Upper Slave R. lowland (Government Hay Camp), no. 1638.

AVENA SATIVA L. — Successfully cultivated far northward in the Mackenzie valley, and known to ripen in the delta of that river. — Upper Slave R. lowland (Government Hay Camp), no. 1637.

Deschampsia cespitosa (L.) Beauv. var. **glauca** (Hartm.) Lindm. — See Rhod. **28**: 154 (1926). — Common about the margins of wet sloughs and on damp sandy or rocky shores in the forested central parts of the Mackenzie basin and southward. Noted by Richardson in Fl. Bor.-Am. on Great Bear Lake. — Calumet, Athabaska R., no. 209. Lake Athabaska: Shelter Pt., nos. 207, 208, 210, 211; Sand Pt., nos. 4499, 4647; mouth of Charlot R., no. 6337, and *Harper*, no. 90053(O); W. shore of Ellis Bay, no. 6368; Charlot Pt., no. 6382; Cornwall Bay, no. 6552. Peace R. delta, no. 216; upper Slave R. lowland, nos. 1660, 1662, 1664. Great Slave L.: Keith Isl., no. 217; Fairchild Pt., nos. 212, 213, 215; Ft. Reliance, no. 214.

Deschampsia mackenzieana, sp. nov. PLATE 190[1]

Gramen perenne caespitosum, 3–8 dm. altum, paniculis laxis patulis 12–20 cm. longis, 8–14 cm. latis, ramis gracilibus infra medium divisis et basi excepta scabris; caules graciles, glabri; folia angusta, involuta, dimidio breviora quam planta, laminis et vaginis glabris; ligulae lanceolatae, 3–5 mm. longae. Spiculae 6–7 mm. longae; glumae aequilongae, acute acuminatae, apicem floris superioris circa attingentes, sed ab arista superatae; spiculae 1–2-florae, lemmatibus circa 4.5–5.5 mm. longis laevigatis scariosis, apice acuto erosis, 4-nerviis (nervo medio aristam formante), paleis scariosis 2-nerviis apice erosis 3.5–4.5 mm. longis, nervis scabris; aristae ad medium lemmatum vel 2/3 basin versus insertae, et lemmatibus circa 2 mm. longiorae; rhachilla in stipitem pilosum quam palea triente breviorem producta pilis apicem paleae subattingentibus; caryopsis circa 2 mm. longa. — Sandy beach on the south shore of Lake Athabaska near Wolverine Point, July 30, 1935, no. 6707 (Type, G). Another number, 6904, collected August 20, 1935 on the large shifting dunes southwest of William Point, is more mature and smaller in stature, but otherwise matches the type very well. — This species is most nearly related to far-northwestern American forms commonly labeled *D. bottnica* (Wahl.) Trin., and to a species described

[1]PLATE 190. *Deschampsia mackenzieana* Raup. Part of type collection from sandy beach ridges just east of Wolverine Pt., Lake Athabaska, no. 6707; details of spikelets × 5.

from the Bering Sea region by Hultén,[1] *D. beringensis*. From both of these it differs in its larger spikelets (up to 7 mm.), and in its spreading panicles. *D. bottnica* has glumes up to 6 mm. long, but commonly shorter, and *D. beringensis* has them 4–5 mm. long. In both the panicles are characteristically contracted, with upright branches. The awn in *D. bottnica* of the Baltic region is often longer than in our plant, exceeding the lemma by more than 3 mm. From *D. beringensis*, *D. mackenzieana* also differs in having smooth lemmas with awn commonly attached near the middle instead of scabrous lemmas with awns from near the base, in having 2-flowered spikelets instead of having them "often 3-flowered," and in having strongly involute leaves with short ligules (3–5 mm.) instead of flat leaves with ligules 8–13 mm. long. The Athabaska Lake plant is one of the commonest species on the sandy beaches and dunes which line the south shore, and is a prominent sand-binding agent.

Danthonia intermedia Vasey. — Occasional in dry upland prairies of the Paleozoic or younger country, and in small deposits of dry soils about the western end of Lake Athabaska. — Chipewyan, no. 4697.

Danthonia thermalis Scribn. — Apparently rare or occasional on rocky hills about the north shore of Lake Athabaska, but not found elsewhere in the region. — Northwest of Sand Pt., no. 4610; Cornwall Bay, no. 6449.

Calamagrostis purpurascens R. Br. — See Rhod. **35:** 213 (1933). — Frequent in dry rock crevices and on sandy ridges and beaches, chiefly in the pre-Cambrian country but wide-ranging in the Arctic. Not observed on the south side of Lake Athabaska. — Lake Athabaska: Shelter Pt., nos. 253, 4462; Charlot Pt., nos. 6096, 6285, 6287, 6304; Cornwall Bay, no. 6510. Near Selwyn L., lat. 60°20′, long. 104°30′, *J. W. Tyrrell*, no. 28921(O). Ft. Smith, no. 260. Great Slave L.: Taltheilei Narrows, no. 256; Maufelly Pt., no. 262; Fairchild Pt., nos. 257, 258, 259, 261; Ft. Reliance, nos. 254, 255.

Calamagrostis montanensis Scribn. — Known in this region from a single collection on the dry prairie at Peace Point, in the Wood Buffalo Park.

Calamagrostis canadensis (Michx.) Nutt. — See Rhod. **24:** 142 (1922), and **32:** 42 (1930) for treatments of this and its related forms. — This species, with its variety *robusta* is abundant in the moister portions of upland semi-open prairies and at the willow margins of the extensive sloughs in the great river lowlands northward at least

[1]Hultén, Eric. *Flora of Kamtchatka and the Adjacent Islands.* **1:** 107-8 (1927) (Svensk. Vetensk. Akad. Handl. ser. 3, **5**, no. 1).

to Great Slave Lake. In the deltas of the Peace and Athabaska Rivers it forms wide expanses in nearly pure stands, and has been extensively used as a source of wild hay. Eastward in the pre-Cambrian country it occupies slough margins and damp sandy lake shores. — Calumet, Athabaska R., no. 234; Egg L., Athabaska R. delta, *Harper,* no. 47(G). Lake Athabaska: Shelter Pt., nos. 233, 235, 236, 237; 5 mi. E. of Poplar Pt., nos. 6645, 6678; along Archibald R. near its mouth, no. 6738; 2 mi. W. of Ennuyeuse Cr., no. 6999. East shore of L. Mamawi, nos. 1755, 1756, 1757; upper Slave R. lowland, nos. 1751, 1753; lower Slave R., near Pt. Brulé, nos. 231, 232. Great Slave L.: mouth of Rocher R., *Harper,* no. 90055(O); Yellowknife Bay, no. 230.

Calamagrostis canadensis (Michx.) Nutt. var. **robusta** Vasey. — Apparently the commoner form of the species over much of its area. So far as present knowledge indicates, it is more widely distributed in the Mackenzie basin, having been found on the lower Mackenzie River (*Taylor,* O). — Lower Athabaska R.: *Kennicott* (N); Calumet, no. 240. Lake Athabaska: Shelter Pt., nos. 241, 242, 243, 244; Sand Pt., nos. 4574, 4609; mouth of Charlot R., no. 6358, and *Harper,* no. 90058(O); near Wabba L., N. of Cornwall Bay, no. 6481. Tazin R., N. W. T., *Harper,* no. 90059(O). Great Slave L.: Black Bay, E. of Rocher R., *Harper,* nos. 90052, 90054(O); Keith Isl., no. 239; Fairchild Pt., nos. 238, 245, 248, 250, 251; Ft. Reliance, nos. 246, 247, 249; Yellowknife Bay, no. 252; N. W. shore, *Bedford* (O).

Calamagrostis canadensis (Michx.) Nutt. var. **scabra** (Presl) Hitchc. — See Am. Jour. Bot. **21:** 135 (1934). — An arctic form of the species which apparently reaches southward into the margins of the timbered region. Also collected on the west branch of the Thelon River (*J. W. Tyrrell,* O), and at Great Bear Lake (*Richardson,* N). — Black L., E. of L. Athabaska, *J. W. Tyrrell,* no. 17390(O); Black R., *J. W. Tyrrell,* no. 17421(O) (both *C. Langsdorfi* in Tyrrell's list).

Calamagrostis inexpansa Gray var. **brevior** (Vasey) Stebbins. — See Rhod. **32:** 50 (1930). — Common or occasional in semi-open prairies and on the slough margins of lakes and ponds northward to Great Bear Lake (*Richardson,* N). — Lake Athabaska: Cornwall Bay, no. 6554; 5 mi. E. of Poplar Pt., no. 6649; pond margin about 5 mi. S. E. of Wolverine Pt., no. 6810. Upper Slave R. lowlands, nos. 1773, 1777, 1778. Yellowknife Bay, Great Slave L., no. 229.

Calamagrostis neglecta (Ehrh.) Gaertn. — See Rhod. **32:** 53–6 (1930). — Abundant on sandy beaches and dunes on the south side of Lake Athabaska, but apparently rare or occasional elsewhere in the Mackenzie basin. — Lake Athabaska: 2 mi. E. of Wolverine Pt., no. 6722; shifting dunes just E. of Ennuyeuse Cr., nos. 6909, 6925.

Agrostis borealis Hartm. var. **typica** Fern. — See Rhod. **35:** 203–7 (1933). — An arctic species known in the Mackenzie basin only toward the northern margin of the timber. It grows on damp rocky or sandy shores. — Rocky point at N. W. entrance to Black Bay, L. Athabaska, no. 6412; Fairchild Pt., Great Slave L., no. 225.

Agrostis scabra Willd. — *A. hyemalis* of auth., in part. — See Rhod. **35:** 207–12 (1933). — Common in prairie openings, the drier parts of meadow sloughs, and in damp crevices or sandy shores throughout the forested area northward at least to Great Bear Lake (*Richardson,* G). — Lower Athabaska R., *Kennicott* (O). Lake Athabaska: Shelter Pt., 218, 219, 220, 221, 222, 223; near Sand Pt., nos. 4501, 4646; Cornwall Bay, nos. 6442, 6557; 5 mi. E. of Poplar Pt., no. 6699; sand hills, 4 mi. S. E. of Wolverine Pt., no. 6790; pond margin about 5 mi. S. E. of Wolverine Pt., no. 6831. Above Great Falls, Tazin R., *Harper,* no. 90060(O). East shore of L. Mamawi, nos. 1624, 1625; upper Slave R. lowland, nos. 1626, 1627. Fairchild Pt., Great Slave L., no. 224.

Cinna latifolia (Trev.) Griseb. — This species has been very little collected in the Mackenzie basin, although it is probably common in the rich woods of the southern portions. — McMurray, no. 7105; Reed's Portage, upper Athabaska delta, no. 1827; Chipewyan, no. 4678.

Arctagrostis arundinacea Trin. — Apparently rare in the Mackenzie basin, in spite of the rather wide range assigned to it by Richardson ("Cumberland House to Bear Lake"). East of the mountains it has been found only at the eastern edge of the Caribou Mountain Plateau (See Nat. Mus. Can. Bull. 74, p. 109).

Alopecurus aequalis Sobol. — *A. aristulatus* Michx. — *A. geniculatus* var. *aristulatus* (Michx.) Torr. — See Rhod. **27:** 196 (1925). — Occasional on sandy or muddy shores and in semi-dry sloughs northward to Great Bear Lake (*Richardson,* G). Rather common in clearings. It has not been found in the pre-Cambrian country about Lake Athabaska. — Methye Portage, Sask., *J. M. Macoun,* no. 18622(O); McMurray, no. 7100; Reed's Portage, upper Athabaska delta, no. 1607; lower delta of Athabaska R., no. 187; E. shore of L. Mamawi, no. 1605; upper Slave R. lowland, no. 1606; Ft. Smith, no. 188. Great Slave L.: Maufelly Pt., no. 186; Fairchild Pt., nos. 189, 190, 191.

Phleum alpinum L. — Specimens somewhat doubtfully referred to this species have been collected in the Wood Buffalo Park, situated in such a way as to suggest that they are but forms of the introduced *P. pratense.* — Reed's Portage, upper Athabaska R. delta, no. 1790; upper Slave R. lowland (Government Hay Camp), no. 1791.

PHLEUM PRATENSE L. — Introduced in settlements and cabin clearings in the Wood Buffalo Park.

Muhlenbergia Richardsonis (Trin.) Rydb. — See Bull. Torr. Bot. Club, **32:** 600 (1905). — Known in the Mackenzie basin only from collections in the Salt Plains west of the upper Slave River.

Oryzopsis pungens (Torr.) Hitchc. — Occasional in dry woods, apparently throughout the region north to the Wood Buffalo Park. — Clearwater R., Sask., *J. M. Macoun,* no. 29426(O); Calumet, Athabaska R., no. 226. Lake Athabaska: Sand Pt., no. 4624; Charlot Pt., nos. 6106, 6406, 6409; N. shore of Ellis Bay, no. 6116; Cornwall Bay, no. 6509; sand hills about 4 mi. S. E. of Wolverine Pt., no. 6791. Upper delta of Peace R. (Quatre Fourches R.), no. 227.

Oryzopsis canadensis (Poir.) Torr. — See Contr. U. S. Nat. Herb. **24:** 227 and 262 (1925). — Known in this region only in the Salt River country west of the upper Slave River. This species was omitted from the Wood Buffalo Park Catalogue. — Salt R. region, *Camsell,* no. 92000(O).

Oryzopsis asperifolia Michx. — Occasional in dry upland woods northward at least to the Wood Buffalo Park, but not known eastward in the pre-Cambrian region. — Calumet, Athabaska R., no. 228; along Firebag R., near its mouth, no. 6035.

Stipa comata Trin. & Rupr. — A species of the Great Plains which enters our region only on dry prairies in the Wood Buffalo Park, where it is rather common at Peace Point.

Stipa comata Trin. & Rupr. var. **intermedia** Scribn. — Known in our region from a single collection on a granite hill in the Peace-Athabaska delta. — East shore of L. Mamawi, no. 1687.

Stipa Richardsonii Link. — Known in this region only on the dry prairie at Peace Point, in the Wood Buffalo Park.

Beckmannia Syzigachne (Steud.) Fern. — *B. erucaeformis* Amer. auth., not Host. — *B. baicalensis* (W. Kuznetzow) Hultén. — See Rhod. **30:** 27 (1928). — Common on wet pond margins and in meadow sloughs northward to the Mackenzie (*Miss E. Taylor,* N, O). — McMurray, no. 7099; Calumet, Athabaska R., no. 195; N. shore of Ellis Bay, L. Athabaska, no. 6170; E. shore of L. Mamawi, nos. 1639, 1640; upper Slave R. lowland, nos. 1643, 1644. Great Slave L.: Fairchild Pt., nos. 196, 197; Ft. Rae, *Bedford* (O).

Spartina gracilis Trin. — Known in this region only on the Salt Plain prairies west of the Slave R., where it is common. A Richardson specimen in the Gray Herbarium, originally labeled *S. polystachya,* bears the notation "Cumberland House to Bear Lake." This notation

may include, however, the range of *S. pectinata* which may also have been included in *S. polystachya*.

Spartina pectinata Link. — *S. Michauxiana* Hitchc. — See Rhod. **35**: 258–60 (1933). — Apparently rare or occasional, and known thus far from two widely separated collections. Richardson's record for *S. polystachya*, "Cumberland House to Bear Lake," probably refers in part to this species. — McMurray, no. 7058; Resolution, *Onion, Kennicott & Hardisty* (N).

Hierochloë odorata (L.) Wahl. — *Torresia odorata* (L.) Hitchc. — Common in prairie openings, damp beaches, meadows and rock crevices northward at least to Great Slave Lake. — Clearwater R., Sask., *J. M. Macoun*, no. 29488(O); Calumet, Athabaska R., no. 172. Lake Athabaska: Sand Pt., nos. 4566, 4660; N. shore of Ellis Bay, no. 6124; Charlot Pt., nos. 6220, 6241; mouth of Charlot R., no. 6336. Upper delta of Peace R., no. 173; Mountain Portage, Slave R., *Kennicott* (N); Resolution, *Kennicott* (N).

Phalaris arundinacea L. — Occasional in damp meadows in the upland districts of the Wood Buffalo Park, but common in the lowlands about the western end of Lake Athabaska. — Upper Athabaska delta (Mamawi Cr.), no. 1702; lower delta of Athabaska R., no. 198; E. shore of L. Mamawi, no. 1703.

Panicum subvillosum Ashe. — Known in the Mackenzie basin from a single collection south of Lake Athabaska. — Burnt pine woods on sandy ridges along lower Archibald R., no. 6746.

CYPERACEAE

Eriophorum Scheuchzeri Hoppe. — An arctic species known in this region only about Great Slave Lake, but collected farther northward at Great Bear Lake, and on the Mackenzie (*J. M. Bell*, O; *Kennicott* ?, N). — Great Slave L.: Taltheilei Narrows, no. 364; Maufelly Pt., no. 363.

Eriophorum Chamissonis C. A. Mey. forma **albidum** (F. Nyl.) Fern. — See Rhod. **23**: 131 (1921), and **27**: 207 (1925). — Occasional in wet muskegs, chiefly in the pre-Cambrian region. — Lake Athabaska: Shelter Pt., nos. 356, 357; near shore of Royal L., S. of Turnor Pt., no. 6841. Great Slave L.: Resolution, *Kennicott* (N); Fairchild Pt., no. 358.

Eriophorum opacum (Björnstr.) Fern. — Common in muskegs northward to Great Slave Lake. — Clearwater R., Sask., *J. M. Macoun*, no. 32297(O); Calumet, Athabaska R., no. 367. Lake Athabaska: Shelter Pt., nos. 365, 366; mouth of Charlot R., no. 6315; N. of Cornwall Bay, no. 6530; 5 mi. E. of Poplar Pt., nos. 6696, 6703. Great Slave

L.: Taltheilei Narrows, no. 370; Maufelly Pt., no. 368; Fairchild Pt., no. 369.

Eriophorum vaginatum L. — See Rhod. **27:** 203–10 (1925) for a treatment of this and the following three spp. — An arctic species evidently quite rare in the Mackenzie basin, and known thus far from a single locality. — Artillery L., *J. W. Tyrrell,* no. 23138(O), and *Seton & Preble,* no. 78570(O).

Eriophorum spissum Fern. — *E. callitrix* of most Amer. auth. — Common or occasional in the Wood Buffalo Park and southwestward, but not recorded thus far in the pre-Cambrian region. Also found on the lower Mackenzie (*Stringer,* O).

Eriophorum angustifolium Roth. — Common in muskegs in the pre-Cambrian region, and extending northward to Great Bear Lake (*J. M. Bell,* O), but rare or occasional in the Wood Buffalo Park. — Lake Athabaska: near Sand Pt., no. 4537; mouth of Charlot R., no. 6342; 5 mi. E. of Poplar Pt., no. 6659; about 4 mi. S. E. of Wolverine Pt., no. 6784; muskeg about 5 mi. S. E. of Wolverine Pt., no. 6809; William Pt., no. 6844; 2 mi. W. of Ennuyeuse Cr., no. 6996. Great Slave L.: mouth of Mountain R., no. 359; Fairchild Pt., nos. 360, 361, 362.

Eriophorum tenellum Nutt. — Known thus far in this region only from the south side of Lake Athabaska, where it inhabits muskeg shores. — Lake Athabaska: William Pt., no. 6864; muskeg about 3 mi. W. of Ennuyeuse Cr., no. 6971.

Eriophorum viridicarinatum (Engelm.) Fern. — Apparently rare; and found thus far only in the pre-Cambrian parts of this region, where it inhabits sandy lake beaches and muskegs. — Shelter Pt., L. Athabaska, no. 4441; Fairchild Pt., Great Slave L., no. 372.

Scirpus hudsonianus (Michx.) Fern. — *Eriophorum alpinum* L. — Occasional in muskegs, chiefly in the pre-Cambrian country. — Lake Athabaska: near Sand Pt., no. 4643; Camsell Portage, no. 6210; mouth of Charlot R., no. 6329; area of large dunes about 5 mi. S. of William Pt., no. 6880. Great Slave L.: Fairchild Pt., no. 385.

Scirpus cespitosus L. var. **callosus** Bigel. — See Rhod. **23:** 22 (1921). — Locally common in muskegs in the pre-Cambrian areas, where it appears to be limited to districts where sedimentary rocks occur. Noted in Fl. Bor.-Am. (under *Eleocharis*) as occurring throughout Canada to the shores of the Arctic Sea, but the writer has seen no material from north of Great Slave Lake. — Lake Athabaska: near Sand Pt., no. 4625; in large dune area about 5 mi. S. of William Pt., no. 6896. Great Slave L.: Taltheilei Narrows, no. 389; Maufelly Pt., no. 392; Fairchild Pt., nos. 390, 391.

Scirpus validus Vahl. — Abundant on marshy lake shores northward in the Paleozoic and younger country throughout the Wood Buffalo Park, and at least occasional beyond Great Slave Lake (*Bedford*, O). Apparently absent from the pre-Cambrian region. — Lower delta of Athabaska R., nos. 386, 1980; E. shore of L. Mamawi, no. 1982.

Scirpus paludosus A. Nels. — Known in this region only on the Salt Plains west of the upper Slave River, in the Wood Buffalo Park.

Scirpus microcarpus Presl. — Occasional in marshes northward to Great Slave Lake, but apparently limited to the great river lowlands. — Calumet, Athabaska R., no. 388; L. Athabaska, *John Macoun*, no. 32389(O) (*S. sylvaticus* var. *digynus* of Macoun's Cat.); Resolution, *Kennicott* (N).

Scirpus atrocinctus Fern. — Unknown in the Mackenzie basin except on the shores of Lake Athabaska. It inhabits wet shores. — Lake Athabaska; Shelter Pt., no. 387; Sand Pt., no. 4576; mouth of Archibald R., no. 6753.

Scirpus rubrotinctus Fern. — Known in the Mackenzie basin from a single collection on the south shore of Lake Athabaska, where it was growing on sand in about 8 inches of water. — Mouth of Archibald R., no. 6752.

Eleocharis pauciflora Link. — See Rhod. **36**: 377–86 (1934). — Apparently rare, and collected thus far only from two localities in the pre-Cambrian country. — Sandy pond margin about 5 mi. S. E. of Wolverine Pt., L. Athabaska, no. 6833; stony-sandy shore of Keith Isl., Great Slave Lake, no. 374.

Eleocharis palustris (L.) R. & S. — Noted in Fl. Bor.-Am. and Macoun's Cat. as occurring "Throughout Canada to Bear Lake," but the writer has seen no specimens from north of Lake Athabaska and the Wood Buffalo Park. Common to abundant on marshy shores. — Lower delta of Athabaska R., nos. 381, 1963. Lake Athabaska: Shelter Pt., no. 382; pond just N. of Cornwall Bay, no. 6627; 2 mi. W. of Ennuyeuse Cr., nos. 6991, 6994. East shore of L. Mamawi, no. 1964; delta of Peace R., no. 380; upper Slave R. lowland, nos. 384, 1968, 1969; Ft. Smith, no. 383.

Eleocharis calva Torr. — See Rhod. **31**: 68 (1929). — Collected in the Mackenzie basin thus far only on the muddy shore of Slave River. — Upper Slave R. lowland (Government Hay Camp), no. 1973.

Eleocharis uniglumis (Link) Schultes. — See Rhod. **31**: 71 (1929). — On slough margins and damp river banks northward to the Wood Buffalo Park, but apparently not common. It has not been collected in the pre-Cambrian country. — Calumet, Athabaska R., no.

376; island in Slave R. at 30th base line, not far below the mouth of the Peace, no. 375.

Eleocharis acicularis (L.) R. & S. — Common in muddy slough margins in the Wood Buffalo Park and southward, but apparently reaching eastward into the pre-Cambrian only a short distance. — Lower delta of Athabaska R., no. 377. Lake Athabaska: Shelter Pt., nos. 378, 379; Sand Pt., no. 4570; "Athabaska," *Richardson,* no. 32179(O). Upper Slave R. lowland, no. 1974.

Kobresia simpliciuscula (Wahl.) Mackenzie. — Known in the Mackenzie basin from a single collection on Great Slave Lake. — Muskeg pond margin, Fairchild Pt., no. 373.

Carex capitata L. — Apparently rare, and found in muskeg thickets both in the pre-Cambrian country and in the Wood Buffalo Park. It was collected on Methye River by J. M. Macoun (O) in 1888. — Taltheilei Narrows, Great Slave Lake, nos. 329, 330.

Carex Eleocharis Bailey. — *C. stenophylla* of auth., not Wahl. — See N. Am. Fl. **18**: 33–4 (1931). — A northern plains species which has been found only in a small patch of clayey soil on a granite hill in the Athabaska-Peace delta. — Granite knoll on E. shore of L. Mamawi, no. 1958.

Carex Sartwellii Dewey. — Apparently rare in the Wood Buffalo Park and southward, and thus far known only from Paleozoic or younger rocks. It is found in wet meadows. — Clearwater R., Sask., *J. M. Macoun,* no. 31810(O).

Carex siccata Dewey. — Common in dry woods, prairies and sandy shores northward at least to Great Slave Lake. — Clearwater R., Sask., *J. M. Macoun,* nos. 20502, 30306(O); Calumet, Athabaska R., no. 298. Lake Athabaska: Shelter Pt., no. 300; Sand Pt., no. 4622; sandy shore of main lake just W. of Ellis Bay, no. 6267; mouth of Charlot R., no. 6316; Cornwall Bay, no. 6511; along Archibald R. near its mouth, no. 6733. Upper Slave R. lowland, no. 1936; Ft. Smith, no. 297. Great Slave L.: Maufelly Pt., no. 299.

Carex chordorrhiza Ehrh. — Known in the Mackenzie basin only from two localities about Lake Athabaska. It grows in wet muskegs or wet mossy rock crevices. — Lake Athabaska: Cornwall Bay, no. 6551; about 3 mi. W. of Ennuyeuse Cr., no. 6970.

Carex diandra Schrank. — Common on the marshy shores of lakes and ponds northward to Great Slave Lake. Collected on Methye River by J. M. Macoun in 1888. — Lake Athabaska: muskeg pond margins just N. of Cornwall Bay, nos. 6497, 6630. Great Slave L.: Fairchild Pt., no. 294; Yellowknife Bay, no. 293.

Carex disperma Dewey. — *C. tenella* Schkuhr. — Common in muskeg thickets and sloughs northward at least to Lake Athabaska and the Wood Buffalo Park. — Lake Athabaska: Shelter Pt., nos. 306, 307, 4454; near Sand Pt., no. 4512; near mouth of Charlot R., nos. 6345, 6347.

Carex tenuiflora Wahl. — Occasional in damp rock crevices and muskegs, chiefly in the pre-Cambrian country but known also west of the Slave River. — Lake Athabaska: mouth of Charlot R., no. 6321 rocky point at N. W. entrance to Black Bay, no. 6420; 5 mi. E. of Poplar Pt., no. 6682. Great Slave L.: Taltheilei Narrows, no. 336; Fairchild Pt., no. 335.

Carex loliacea L. — A species of far-northwestern affinity known in the Mackenzie basin from three widely separated localities: Lesser Slave Lake, the eastern edge of the Caribou Mountain plateau, and the north shore of Lake Athabaska. — Muskeg N. of Cornwall Bay, L. Athabaska, no. 6483.

Carex brunnescens Poir. var. **sphaerostachya** (Tuckerm.) Kükenth. — See Rhod. **28**: 163 (1926). — Occasional at muskeg slough margins or in damp crevices northward at least to Lake Athabaska and the Wood Buffalo Park. — Clearwater R., Sask., *J. M. Macoun,* no. 30476(O). Lake Athabaska: near Sand Pt., nos. 5412-a, 4605; 5 mi. E. of Poplar Pt., nos. 6650, 6672; along Archibald R., S. of Wolverine Pt., no. 6726; slough along William R. near its mouth, no. 6879.

Carex canescens L. var. **subloliacea** Laestad. — Common at muskeg pond margins throughout the region northward at least to Great Slave Lake. Noted by both Richardson and John Macoun on Methye Portage. — Lake Athabaska: Shelter Pt., nos. 320, 321, 322; near Sand Pt., nos. 4496, 4607; near mouth of Charlot R., no. 6346; just N. of Cornwall Bay, nos. 6494, 6620; 5 mi. E. of Poplar Pt., nos. 6661, 6662, 6694, 6697; along Archibald R., S. of Wolverine Pt., no. 6725; along William R. near its mouth, no. 6878. Great Slave L.: Fairchild Pt., nos. 323, 324; 12 mi. E. of Moraine Pt., N. W. shore, *Bedford* (O).

Carex arcta Boott. — Occasional in wet upland thickets in the Wood Buffalo Park and southwestward.

Carex gynocrates Wormsk. — Common in mossy muskeg timber and thickets northward to Great Slave Lake, and known also in the Arctic. — Clearwater R., *J. M. Macoun,* no. 30560(O). Lake Athabaska: Shelter Pt., no. 331; mouth of Charlot R., nos. 6325, 6327. Great Slave L.: Maufelly Pt., no. 333; Fairchild Pt., nos. 332, 334.

Carex Deweyana Schw. — Common or occasional in woods and thickets at the southern borders of the region. — Methye Portage, *J. M. Macoun,* no. 30463(O); McMurray, no. 7046.

Carex praticola Rydb. — *C. pratensis* Drejer. — Common in prairie openings and open woods northward in the Paleozoic and younger country at least to the Wood Buffalo Park. — Clearwater R., Sask., *J. M. Macoun,* nos. 31668(O); 13403(G, O); granite hill on E. shore of L. Mamawi, no. 1905.

Carex Crawfordii Fern. — Collected in this region only in one locality on the northwest shore of Lake Athabaska, where it is rather common on damp stony beaches. A Richardson specimen in the Gray Herbarium is marked "Carlton House and Bear Lake," but we have no other indication that the species occurs so far northward. It is also known in the southwestern part of the Mackenzie basin. — Shelter Pt., L. Athabaska, nos. 290, 291, 292, 4439.

Carex Bebbii Olney. — Occasional at damp slough margins northward to the Athabaska River delta and the lower Peace River, and common in the southwestern part of the Mackenzie basin. Collected on Methye River by J. M. Macoun. — Reed's Portage, upper Athabaska delta, no. 1959.

Carex tenera Dewey. — Occasional on damp upland slough margins in the Wood Buffalo Park, but otherwise unknown in the Mackenzie basin.

Carex aenea Fern. — Occasional in rock crevices and on dry sandy beaches and plains on the north shore of Lake Athabaska, but not known elsewhere in the Mackenzie basin. — Chipewyan, no. 6074; near Sand Pt., nos. 4506, 4623; N. shore of Ellis Bay, no. 6110; Charlot Pt., no. 6254.

Carex sychnocephala Carey. — Known in the Mackenzie basin from only two localities, one in the Wood Buffalo Park, and the other at the western end of Lake Athabaska. — Damp roadway just back of Chipewyan, no. 7017.

Carex leptalea Wahl. — Occasional in muskegs in the pre-Cambrian parts of this region, and known northward along the Mackenzie (*Richardson,* N). — Shore of L. Athabaska near Sand Pt., no. 4489; Fairchild Pt., Great Slave L., no. 304.

Carex obtusata Liljebl. — A species of dry prairies found in this region only in the Wood Buffalo Park, and on dry turfy slopes at the western end of Lake Athabaska. — Chipewyan, nos. 4681, 6070.

Carex supina Wahl. — Apparently rare, and found thus far only in the pre-Cambrian region where it grows on exposed rocky or sandy slopes. Also known at Great Bear Lake (*Richardson,* G, N). — Lake Athabaska: Charlot Pt., nos. 6101, 6288; high hill S. of Wabba L., no. 6470. Great Slave L.: Ft. Reliance, no. 283.

Carex deflexa Hornem. — Occasional in dry rock crevices and gravelly or sandy shores about Lake Athabaska, but otherwise unknown in the Mackenzie basin east of the mountains except at Methye Portage. — Methye Portage, *Richardson* (O) (*C. novae-angliae* of Rich. Arctic Searching Exped.). Lake Athabaska: north shore of Charlot Isl., nos. 6166, 6167; Camsell Portage, no. 6205; Cornwall Bay, no. 6456; high hill S. of Wabba L., no. 6471; 5 mi. E. of Poplar Pt., no. 6651; about 4 mi. S. E. of Wolverine Pt., no. 6793?.

Carex Rossii Boott. — Apparently rare, and known thus far only in the Paleozoic and younger country northward to the Wood Buffalo Park, where it inhabits dry soils. — Clearwater R., Sask., *J. M. Macoun*, no. 32007(O); Ft. Smith, no. 326.

Carex umbellata Schkuhr var. **tonsa** Fern. — *C. tonsa* (Fern.) Bicknell. — Noted by Richardson in 1845 at Methye Portage and Ft. Simpson, but the writer has seen only the following material. — Lake Athabaska: Chipewyan, *Richardson* (G) (*C. umbellata* of Fl. Bor.-Am. and Macoun's Cat.); open woods of small jack pine S. of Wolverine Pt., no. 6724.

Carex scirpoidea Wahl. — An arctic and alpine species known in this region only from the pre-Cambrian country, where it grows in muskegs or rocky crevices and slopes, and seems to be confined to dolomitic rocks. — Lake Athabaska: Cornwall Bay, nos. 6447, 6448; hills N. W. of Cornwall Bay, no. 6522. Great Slave L.: Taltheilei Narrows, no. 309; Fairchild Pt., nos. 308, 310, 311; N. W. shore, *Bedford* (O).

Carex concinna R. Br. — Occasional or common in muskeg thickets or damp crevices throughout the wooded region northward to Great Bear Lake (*Richardson,* G). — Lake Athabaska: Charlot Pt., nos. 6227, 6301, 6385; west shore of Ellis Bay, no. 6372; rocky hills N. W. of Cornwall Bay, no. 6537. Great Slave L.: Taltheilei Narrows, no. 265; Maufelly Pt., no. 263; Fairchild Pt., no. 264.

Carex Richardsonii R. Br. — Common or occasional on dry bluffs and in dry open woods northward to the Wood Buffalo Park, but scarcely extending into the pre-Cambrian region. — Along Firebag R. near its entrance to the Athabaska, no. 6039; Chipewyan, no. 6076; Ft. Smith, nos. 303, 1885.

Carex glacialis Mackenzie. — *C. pedata* Wahl. — An arctic species, apparently rare in the Mackenzie basin and known only from the following localities. It grows on high rock ledges, and seems confined to dolomitic rocks. — Hills N. E. of Cornwall Bay, L. Athabaska, no. 6521; Fairchild Pt., Great Slave L., no. 282.

Carex eburnea Boott. — Although originally described from ma-

terial collected by Richardson at Fort Norman on the Mackenzie, this species has been collected in only one other place in the Mackenzie basin east of the mountains. — Dolomitic hills N. E. of Cornwall Bay, no. 6520.

Carex Garberi Fern. — See Rhod. **37**: 253–5 (1935). — On damp sandy or muddy shores and in muskegs on the eastern arm of Great Slave Lake. Not recorded elsewhere in the Mackenzie basin except on the Peace River just east of the mountains (under *C. Hassei* in Contr. Arn. Arb. **6**: 33). — Great Slave L.: Keith Isl., no. 271; Fairchild Pt., nos. 272, 273.

Carex aurea Nutt. — Occasional on damp muddy or sandy shores or in rich woods, chiefly in the Paleozoic and younger country to the Mackenzie (*Richardson,* G). — "Isle a la Crosse to Methye Portage," *Onion, Kennicott & Hardisty* (N); E. end of L. Athabaska, *Campbell,* no. 132423(O); Ft. Smith, no. 295.

Carex vaginata Tausch. — Common in muskeg thickets throughout most of the region northward to Great Bear Lake (*Richardson,* G). — Clearwater R., Sask., *J. M. Macoun,* no. 30704 (G, O) (the specimen in Gray Hb. is unnumbered, but is evidently a duplicate). Lake Athabaska: mouth of Charlot R., no. 6314; just south of Wabba L., N. of Cornwall Bay, no. 6486. Great Slave L.: Taltheilei Narrows, no. 266; Maufelly Pt., no. 268; Fairchild Pt., nos. 267, 269, 270. Last woods, E. shore of Artillery L., *Seton & Preble,* no. 87-c(O).

Carex capillaris L. — Common in muskeg thickets and damp crevices northward to the Mackenzie country (*Richardson,* G, N), and noted by Richardson at Great Bear Lake. — Lake Athabaska: near Sand Pt., no. 4645; Camsell Portage, nos. 6204, 6209; Charlot Pt., no. 6386. Great Slave L.: Maufelly Pt., no. 312; Fairchild Pt., nos. 313, 314, 315.

Carex Oederi Retz. var. **pumila** (Cosson & Germ.) Fern. — *C. viridula* Michx. — Apparently rare or occasional on damp shores in the pre-Cambrian country northward to Great Slave Lake. — Clearwater R., Sask., *J. M. Macoun,* no. 25479(O). Lake Athabaska: near Sand Pt., nos. 4488, 4644; rocky point at the N. W. entrance to Black Bay, no. 6419. Great Slave L.: Keith Isl., no. 305.

Carex abbreviata Prescott. — *C. Torreyi* Tuckerm. — Apparently occasional northward in the Paleozoic and younger country to the Wood Buffalo Park, where it inhabits dry prairies. — Clearwater R., *J. M. Macoun,* no. 7458(G, O) (the specimen in Gray Hb. has no number but is of the same date and locality).

Carex lasiocarpa Ehrh. — Abundant on sandy pond and slough

margins on the south side of Lake Athabaska. Known elsewhere in the Mackenzie basin only by somewhat questionable records for closely related species. *Carex lanuginosa* was noted by Richardson at Methye Portage in 1845, and this record was apparently referred to *C. Houghtonii* in Macoun's Catalogue. There is a Richardson specimen of *C. Houghtonii* in Herb. O. marked "Cumberland House to Fort Chipewyan," but its actual locality is entirely uncertain. — Lake Athabaska: pond margin about 4 mi. S. E. of Wolverine Pt., no. 6785; pond margins about 5 mi. S. E. of Wolverine Pt., no. 6813; William Pt., no. 6853; about 2 mi. W. of Ennuyeuse Cr., no. 6993.

Carex limosa L. — Occasional in wet muskegs northward at least to Great Slave Lake, chiefly in the pre-Cambrian country. — Lake Athabaska: near Sand Pt., no. 4482; along William R. near its mouth, no. 6862; muskeg about 3 mi. W. of Ennuyeuse Cr., no. 6972. Great Slave L.: Fairchild Pt., nos. 286, 287, 288.

Carex paupercula Michx. var. **irrigua** (Wahl.) Fern. — Common in wet muskegs northward at least to Great Slave Lake. It appears to be most common in the pre-Cambrian country, but is also known in the Wood Buffalo Park. — Lake Athabaska: Shelter Pt., no. 327; 5 mi. E. of Poplar Pt., nos. 6658, 6671. Great Slave L.: Fairchild Pt., no. 328.

Carex Parryana Dewey. — Known in the Mackenzie basin from a single collection on Great Slave Lake. — Taltheilei Narrows, no. 325.

Carex Vahlii Schkuhr var. **inferalpina** (Wahl.) Fern. — *C. Halleri* Gunn. — See Rhod. **35:** 220–3, 398 (1933). — Occasional to common in muskeg thickets and damp prairie margins northward to Great Bear Lake (*Richardson,* G), but not thus far collected on Great Slave Lake. — Methye Portage, *J. M. Macoun,* no. 13408(O); Calumet, Athabaska R., no. 284. Lake Athabaska: Shelter Pt., no. 285; Sand Pt., nos. 4500, 4505; Camsell Portage, no. 6208; near mouth of Charlot R., no. 6350; W. shore of Ellis Bay, no. 6373.

Carex atratiformis Britton. — Occasional in wet woods and thickets in the Wood Buffalo Park and southward, but not found thus far in the pre-Cambrian country or the lowlands bordering it.

Carex Buxbaumii Wahl. — Occasional at the willow margins of prairie openings in the Wood Buffalo Park, and in damp crevices or sandy shores about Lake Athabaska, but not recorded elsewhere in the Mackenzie basin. — Lake Athabaska: Camsell Portage, no. 6206; mouth of Charlot R., nos. 6324, 6344; pond margin about 5 mi. S. E. of Wolverine Pt., no. 6812.

Carex concolor R. Br. — *C. rigida* Good. — An arctic species known in the Mackenzie basin only in the margin of the timber. In

addition to the following it has also been collected at Great Bear Lake (*Richardson,* G, N). — Last woods, E. shore of Artillery L., *Seton & Preble,* no. 78295(O) (*C. rigida* of Seton's list).

Carex lenticularis Michx. — Although noted in Fl. Bor.-Am. as occurring from "Canada to the Mackenzie River," this species has been very little collected east of the mountains. It was collected at Great Bear Lake by Richardson (G, N) and recorded by him at Methye Portage (1845), but otherwise the following is the only record for the Mackenzie basin. It grows on damp sandy beaches. — Shelter Pt., L. Athabaska, no. 318.

Carex aquatilis Wahl. — One of the commonest sedges of sandy and marshy shores throughout the region and northward to the Arctic. It is extremely variable in form. — "Isle a la Crosse to Methye Portage," *Kennicott* (N); Methye Portage, *Richardson* (O); "between Lake Superior and Chipewyan," *Richardson* (O); Clearwater R., *J. M. Macoun,* no. 13414(O). Lake Athabaska: Shelter Pt., nos. 352, 353; Sand Pt., no. 4606; mouth of Charlot R., nos. 6323, 6349; small pond just N. of Cornwall Bay, no. 6628; 5 mi. E. of Poplar Pt., nos. 6660, 6676; along Archibald R., S. of Wolverine Pt., nos. 6728, 6739; about 4 mi. S. E. of Wolverine Pt., nos. 6776, 6786; William Pt., nos. 6847, 6877; wet places among dunes about 5 mi. S. of William Pt., no. 6891; about 2 mi. W. of Ennuyeuse Cr., nos. 6986, 7009. East shore of L. Mamawi, no. 1841; Peace R. delta, no. 338; upper Slave R. lowland, nos. 1842, 1847, 1848; Slave R. delta, nos. 340, 350. Great Slave L.: Keith Isl., no. 341; Taltheilei Narrows, no. 337; Fairchild Pt., nos. 342, 343, 344, 346, 347, 348, 351; Maufelly Pt., no. 339; Ft. Reliance, no. 345; island in Charlton Bay, no. 354; Yellowknife Bay, no. 349; N. W. shore, *Bedford* (O); Ft. Rae, *Bedford* (O).

Carex trichocarpa Muhl. var. **aristata** (R. Br.) Bailey. — *C. atherodes* Spreng. — One of the most abundant sedges in the Paleozoic country, especially in the great river lowlands, but not found thus far in any part of the pre-Cambrian regions. Known also on the Mackenzie (*Richardson,* N). It occupies a variety of habitats ranging from lake shores, where it stands in water 4 feet deep, to nearly dry sloughs. — Lower delta of Athabaska R., nos. 317, 1857; E. shore of L. Mamawi, no. 1858; upper Slave R. lowland, nos. 1860, 1861, 1862; lower Slave R., no. 316.

Carex physocarpa Presl. — An arctic species known in this region only on the north shore of Lake Athabaska where it grows in damp crevices on the shore. — Small island about 2 mi. E. of Crackingstone Pt., no. 6422; near base of Cornwall Bay, no. 6556.

Carex saxatilis L. — Known in our region from a single collection on Great Slave Lake, where it was found growing at the margin of a pond. The writer has seen no other Mackenzie basin specimens except one secured on the lower Mackenzie River by Dutilly (Herb. G.) — Fairchild Pt., no. 301.

Carex saxatilis L. var. **miliaris** (Michx.) Bailey. — Apparently rare, and thus far collected in the Mackenzie basin from a single locality on Lake Athabaska where it grows on sandy and stony shores. — Shelter Pt., nos. 319, 4437.

Carex Raeana Boott. — The type of this species was collected by Richardson at Methye Portage, but is otherwise unknown in the Mackenzie basin. The writer has not seen this type, but there is a Richardson specimen in Herb. O., without date or locality, which may be a part of it.

Carex membranopacta Bailey. — *C. membranacea* Hook. — *C. compacta* R. Br. — An arctic species entering our region only in the Lockhart basin and on Great Slave Lake, where it grows on rocky pond margins. It is also known at Great Bear Lake (*Richardson*). — Fairchild Pt., Great Slave L., no. 302; last woods, E. shore of Artillery L., *Seton & Preble*, no. 78296(O).

Carex rostrata Stokes. — An extremely common and variable species found at the margin of nearly every slough pond in the timbered regions, and extending northward to Great Bear Lake and the Mackenzie (*Richardson*, G, N). With *C. aquatilis* it makes up most of this type of vegetation. — Methye Portage, *Richardson*, no. 32037(O) (*C. utriculata* of Richardson's list of 1845, and of Macoun's Cat.), and *John Macoun*, no. 32032(O) (*C. utriculata* of Macoun's Cat.); Clearwater R., Sask., *J. M. Macoun*, July 17, 1888, no. 32034(O), and July 11, 1888(G). Lake Athabaska: Shelter Pt., no. 276; pond just N. of Cornwall Bay, no. 6629; along Archibald R., near its mouth, no. 6765; William Pt., nos. 6846, 6850, 6866; about 3 mi. W. of Ennuyeuse Cr., no. 6966; about 2 mi. W. of Ennuyeuse Cr., no. 7001. Lower delta of Athabaska R., no. 1828; upper Slave R. lowland, nos. 1830, 1834, 1838; lower Slave R., nos. 274, 277, 278, 281. Great Slave L.: Fairchild Pt., nos. 275, 280; Yellowknife Bay, no. 279; N. W. shore, *Bedford* (O).

Carex retrorsa Schwein. — Known in this region only in the southwestern part of the Wood Buffalo Park, along the Peace River.

Carex oligosperma Michx. — Common on sandy pond margins on the south side of Lake Athabaska, and known also at the widely separated localities — Methye Portage (*John Macoun*), and Great Bear

Lake (*Richardson,* G). Otherwise it is not known in the Mackenzie basin. — Methye Portage, *John Macoun,* no. 31548(O). Lake Athabaska: about 4 mi. S. E. of Wolverine Pt., no. 6777; about 5 mi. S. E. of Wolverine Pt., no. 6814; William Pt., no. 6852.

ARACEAE

Calla palustris L. — Occasional in muskeg and flood plain sloughs northward at least to Great Slave Lake. — Delta of the Athabaska R. (Mamawi Cr.), no. 1994. Lake Athabaska: Shelter Pt., nos. 394, 395, 4419; 5 mi. E. of Poplar Pt., no. 6674. Upper Slave R. lowland, no. 1993. Great Slave L.: S. W. and N. shores, *Howe,* no. 91988(O); N. W. shore, *Bedford* (O).

LEMNACEAE

Lemna minor L. — Probably common in slough ponds throughout most of the region northward at least to Great Slave Lake, but very little collected. — Muskeg pond N. of Cornwall Bay, L. Athabaska, no. 6499; upper Slave R. lowland, no. 394-a; Yellowknife Bay, Great Slave L.

Lemna trisulca L. — Abundant in a slough pond in the Murdock Creek district, west of the upper Slave River. There are no other well-authenticated records for the Mackenzie basin, although there is a Richardson specimen in Herb. O. marked "From Cumberland House to Fort Chepewyan, June–July, 1820." It was collected by J. M. Macoun on Methye River in 1888, no. 28117(O), and is probably widespread at least in the southern part of the region. — Upper Slave R. lowland, no. 1995.

JUNCACEAE

Juncus bufonius L. — Noted in Fl. Bor.-Am. as occurring northward to Great Bear Lake, but the writer has seen no material from beyond the Wood Buffalo Park. It is occasional on damp slough margins, sandy lake shores, and in rock crevices, apparently not extending far into the pre-Cambrian country. — Lake Athabaska: Chipewyan, no. 4695; Shelter Pt., no. 407; along Ennuyeuse Cr., near its mouth, no. 6928. Granite hill on W. shore of L. Mamawi, no. 2009.

Juncus bufonius L. var. **halophilus** Buchenau & Fern. — Known in the Mackenzie basin only from the south side of Lake Athabaska, where it was growing on a wet river sand bar. — William R. near its mouth, no. 6871.

Juncus Dudleyi Wieg. — Known in the Mackenzie basin from a single locality. — Damp slough at Chipewyan, L. Athabaska, nos. 4691, 7019.

Juncus Vaseyi Engelm. — Common at upland slough margins and on damp sandy plains and shores northward at least to Lake Athabaska and the Wood Buffalo Park. — Lake Athabaska: Chipewyan, nos. 7018, 7044; Shelter Pt., nos. 411, 412, 4440; Sand Pt., nos. 4553, 4655; rocky point at N. W. entrance to Black Bay, no. 6414; pond margins about 5 mi. S. E. of Wolverine Pt., no. 6817.

Juncus arcticus Willd. — An arctic and alpine species, common on sandy and muddy shores about the eastern arm of Great Slave Lake, but not thus far collected elsewhere in this region (see note under *J. balticus* var. *littoralis*). — Great Slave L.: Keith Isl., no. 414; Taltheilei Narrows, no. 421; Fairchild Pt., nos. 420, 422, 423; base of Maufelly Pt., no. 413; Ft. Reliance, nos. 418, 419.

Juncus balticus Willd. var. **littoralis** Engelm. — Common on muddy and sandy shores northward in the great river lowlands to the lower Mackenzie (*Miss E. Taylor*, O). It is abundant about Lake Athabaska and on the Salt Plains, but on Great Slave Lake its place is largely taken by *J. arcticus*. Part of the Athabaska Lake material cited below (nos. 6772, 6892) appears to be intermediate between this species and *J. arcticus*. It has the inflorescences of *J. balticus littoralis*, but the capsules are nearly black and mature longer than the sepals as in *J. arcticus*. — Methye Portage, *J. M. Macoun*, no. 27802(O); Calumet, Athabaska R., no. 415. Lake Athabaska: Shelter Pt., nos. 416, 417; Sand Pt., no. 4567; N. shore of Ellis Bay, no. 6171; mouth of Charlot R., nos. 6328, 6330; Cornwall Bay, no. 6609; mouth of Archibald R., no. 6772; wet places among dunes about 5 mi. S. of William Pt., no. 6892; among dunes just E. of Ennuyeuse Cr., no. 6906. Upper Slave R. lowland, no. 2004; Slave R., *Richardson* (G) (*J. balticus* in Fl. Bor.-Am.).

Juncus filiformis L. — Apparently occasional northward to Lake Athabaska and the Wood Buffalo Park, on wet stony-sandy shores and plains. Noted in Fl. Bor.-Am. as extending to Great Bear Lake. — Lake Athabaska: Shelter Pt., nos. 410, 4438; Sand Pt., no. 4551; along Archibald R., S. of Wolverine Pt., no. 6727; mouth of Archibald R., no. 6754; damp places among dunes about 5 mi. S. of William Pt., no. 6895-a.

Juncus brevicaudatus (Engelm.) Fern. — Abundant on wet sandy shores, chiefly of ponds and beach lagoons, about Lake Athabaska, but not known elsewhere in the Mackenzie basin. — Lake Athabaska: Shelter Pt., no. 4424; Sand Pt., no. 4552; ponds about 5 mi. S. E. of Wolverine Pt., nos. 6830, 6832; William Pt., nos. 6851, 6863, 6870; small pond among big dunes about 5 mi. S. of William Pt., no. 6881;

along Ennuyeuse Cr. near its mouth, no. 6928-a; about 2 mi. W. of Ennuyeuse Cr., no. 6981.

Juncus nodosus L. — Common on wet sandy or muddy shores northward mainly in the Paleozoic and younger country, and reaching to the Mackenzie R. (*Onion,* N). In Fl. Bor.-Am., as *J. polycephalus* var. *tenuifolius,* it is noted at Great Bear Lake. — McMurray, no. 7062; lower delta of Athabaska R., no. 408; Shelter Pt., L. Athabaska, no. 409; upper Slave R. lowland, no. 2007; Ft. Smith, *Russell,* no. 28(O).

Juncus alpinus Vill. — Occasional on wet sandy or muddy shores, mainly in the pre-Cambrian country. — Lake Athabaska: Shelter Pt., no. 402; near Sand Pt., no. 4634. Lower delta of the Peace R., no. 401. Great Slave L.: Keith Isl., no. 405; Maufelly Pt., no. 406; Fairchild Pt., nos. 403, 404.

Juncus alpinus Vill. var. **rariflorus** (Hartm.) Hartm. — *J. alpinus* Vill. var. *insignis* Fries. — *J. Richardsonianus* Schultes. — See Botaniska Notiser, **1932:** 313–72, and Rhod. **35:** 233–34 (1933). — Occasional on damp muddy shores, with a range in this region not unlike that of the species. Known also on the Mackenzie (*Richardson* ?, G; *Onion,* N). — Lake Athabaska: Chipewyan, no. 4699; Sand Pt., no. 4564. Upper Slave R. lowland, no. 1999. Great Slave L., *Richardson* ? (G) (*J. acutiflorus* in Fl. Bor.-Am., in part).

Juncus albescens (Lange) Fern. — *J. triglumis* L. var. *albescens* Lange. — See Rhod. **26:** 201–3 (1924). — Known in the Mackenzie basin only at the eastern end of Great Slave Lake where it was growing in a limey upland swamp. — Fairchild Pt., no. 396.

Juncus stygius L. var. **americanus** Buchenau. — Collected thus far in the Mackenzie basin from a single locality on the south side of Lake Athabaska. — Wet slough on William Pt., no. 6869.

Juncus castaneus Smith. — An arctic and alpine species, occasional or common in muskegs or on wet sandy and gravelly shores southward in this region to the lower Athabaska River. It is frequent about Great Slave Lake, but has not yet been collected on Lake Athabaska nor in the Wood Buffalo Park. — Calumet, Athabaska R., no. 397. Great Slave L.: Taltheilei Narrows, no. 398; Fairchild Pt., nos. 399, 400.

Luzula confusa Lindeb. — *L. hyperborea* R. Br., in part. — An arctic species known in the Mackenzie basin from a single collection northeast of Great Slave Lake. — Last woods, E. shore of Artillery L., *Seton & Preble,* no. 78927(O).

Luzula campestris (L.) DC. var. **alpina** Gaud. — *L. sudetica* Willd. — Apparently rare in the Mackenzie basin, and known only from Great Slave and Great Bear (*J. M. Bell,* O) Lakes not far south

of the margin of the timber. — Taltheilei Narrows, Great Slave L., no. 424.

LILIACEAE

Tofieldia palustris Huds. — Common in muskegs in the more arctic parts of the pre-Cambrian country, and northward. — Lake Athabaska: near Sand Pt., no. 4626. Great Slave L.: Taltheilei Narrows, no. 425; base of Maufelly Pt., no. 428; Fairchild Pt., nos. 426, 427, 429, 430, 431; S. W. and N. shores, *Howe,* no. 91987(O); N. W. shore, *Bedford* (O).

Tofieldia glutinosa (Michx.) Pers. — See Contr. Arn. Arb. 6:137 (1934). — Noted in Fl. Bor.-Am. as occurring "throughout Canada, to . . . Bear Lake," and there is a Richardson specimen in Herb. G. labeled "Cumberland House to Bear Lake." Otherwise unknown in the Mackenzie basin east of the mountains except for a single specimen from an upland muskeg west of the Slave River, in the Wood Buffalo Park.

Zygadenus elegans Pursh. — *Anticlea elegans* (Pursh) Rydb. — See Rhod. **37**: 256–8 (1935). — A species of the northern plains and mountains, extending northward in the Paleozoic country to the lower Mackenzie (*Miss E. Taylor,* G, N), and Bear Lake (*Richardson,* G). — Great Slave L.: S. W. and N. shores, *Howe,* nos. 91986, 91985(O); Windy Pt., *Hume,* no. 102657(O); N. W. shore, *Bedford* (O); Old Fort Rae, *Russell* (O).

Allium Schoenoprasum L. var. **sibiricum** (L.) Hartm. — *A. sibiricum* L. — Occasional on damp sandy or gravelly shores and in rock crevices; widely distributed throughout the Mackenzie basin, but mostly in the Paleozoic or younger country. — Lake Athabaska: Shelter Pt., no. 435; Charlot Pt. and vicinity, nos. 6229, 6242, 6380; N. shore, *J. W. Tyrrell,* no. 27419(O). Great Slave L.: N. W. shore, *Bedford* (O); "Carlton House to Slave Lake," *Richardson* (G) (*A. Schoenoprasum* in Fl. Bor.-Am. and Macoun's Cat.).

Lilium philadelphicum L. var. **andinum** (Nutt.) Ker. — Apparently limited to the southern parts of the Mackenzie basin, and known in our region only on the lower Athabaska River. — McMurray, no. 7115; Calumet, no. 435.

Smilacina stellata (L.) Desf. — *Vagnera stellata* (L.) Morong. — Rather common in thickets and semi-open prairies northward in the Paleozoic or younger country to the Wood Buffalo Park. — Granite hill on E. shore of L. Mamawi, nos. 2016, 4411.

Smilacina trifolia (L.) Desf. — *Vagnera trifolia* (L.) Morong. — Common in wet muskegs, where it usually grows on hummocks of

Sphagnum and other mosses. Noted in Fl. Bor.-Am. as extending northward to Great Bear Lake but the writer has seen no material from beyond the south shore of Great Slave Lake. — Lake Athabaska: Shelter Pt., nos. 432, 433; Sand Pt., no. 4532; 5 mi. E. of Poplar Pt., no. 6665; 2 mi. W. of Ennuyeuse Cr., no. 7011; "From Cumberland House to Fort Chepewyan," *Richardson*, no. 27609(O). Resolution, *Kennicott* (N).

Maianthemum canadense Desf. var. **interius** Fern. — *Unifolium canadense* (Desf.) Greene var. *interius* (Fern.) House. — See Rhod. **16:** 211 (1914). — Abundant in woods northward to Lake Athabaska and the Wood Buffalo Park. Although known on the Mackenzie (*Miss E. Taylor*, N) and noted in Fl. Bor.-Am. at Great Bear Lake, it has not been collected on Great Slave Lake. — Calumet, Athabaska R., no. 439. Lake Athabaska: Shelter Pt., nos. 437, 438, 440, 442; Sand Pt., no. 4650; near tip of Elliot Pt., no. 6427; 5 mi. E. of Poplar Pt., no. 6687; along Archibald R. near its mouth, no. 6763; 2 mi. W. of Ennuyeuse Cr., no. 6936; N. shore, *J. W. Tyrrell*, no. 116237(O). Upper delta of Peace R. (Quatre Fourches R.), no. 441; Ft. Smith, no. 436; and *Miss E. Taylor*, no. 27537(O); and *Seton & Preble*, no. 78569(O).

Disporum trachycarpum (Wats.) Benth. — Common in upland, rather open woods in the southern parts of the Mackenzie basin, but not known north of the lower Athabaska. — Lac la Biche, no. 2021; Waterways, no. 2022; McMurray, no. 7110; along the Firebag R. near its mouth, no. 6044.

IRIDACEAE

Sisyrinchium angustifolium Miller. — Common in dry prairie openings, rock crevices, and on stony or sandy lake shores northward to Lake Athabaska and the Wood Buffalo Park. It is known on the upper Mackenzie (*Miss E. Taylor*, O), but has not yet been recorded on Great Slave Lake. — Calumet, Athabaska R., no. 444. Lake Athabaska: Chipewyan, *Laing*, no. 63(N); Shelter Pt., nos. 443, 445; Sand Pt., no. 4632; small island at base of Charlot Pt., no. 6378; mouth of Charlot R., no. 6326; Fishhook Bay, no. 6586; Cornwall Bay, no. 6606.

ORCHIDACEAE

Cypripedium passerinum Richards. — See Trans. Roy. Soc. Can. ser. 3, sect. 5, **22:** 163–172 (1928). — Occasional in rather dry woods throughout most of the timbered country, north to the Mackenzie (*Miss E. Taylor*, G, N, O; *R. M. Anderson*, N). Although widely distributed about Great Slave Lake it has not been found on Lake Athabaska. — Lower Slave R., no. 469. Great Slave L.: Maufelly Pt., no. 470; Fairchild Pt., no. 471; N. W. shore, *Bedford* (O).

Cypripedium guttatum Swartz. — A species of far-northwestern affinity, known in our region only on Great Slave Lake. — Great Slave L.: *R. Bell,* no. 23156(O); Maufelly Pt., no. 468; Old Fort Rae, *Russell* (O).

Cypripedium acaule Ait. — Common on dry sandy plains and ridges about Lake Athabaska, but not known elsewhere in the Mackenzie basin except on Great Bear Lake (*Richardson,* G). — Lake Athabaska: Sand Pt., nos. 4471, 4486, 4601, 4656; 5 mi. E. of Poplar Pt., no. 6636; 2 mi. E. of Wolverine Pt., no. 6800; pine woods among dunes just E. of Ennuyeuse Cr., no. 6917.

Orchis rotundifolia Pursh. — Rather common in timbered muskegs northward at least to Great Slave Lake. — Calumet, Athabaska R., no. 478. Lake Athabaska: muskeg N. W. of Cornwall Bay, no. 6515. Ft. Smith and vicinity, no. 475; and *Miss E. Taylor* (G, N, O). Great Slave L.: *Onion* (N); Keith Isl., no. 479; Maufelly Pt., no. 477; Fairchild Pt., nos. 476, 480, 481; Windy Pt., *Hume* (O); N. W. shore, *Bedford* (O); Old Fort Rae, *Russell* (O).

Habenaria viridis (L.) R. Br. var. **bracteata** (Willd.) Gray. — *Coeloglossum bracteatum* (Willd.) Parl. — Occasional in dry upland woods and thickets northward in the Paleozoic and younger country at least to the Wood Buffalo Park. — Calumet, Athabaska R., no. 458.

Habenaria hyperborea (L.) R. Br. — *Limnorchis hyperborea* (L.) Rydb. — Rather common in muskegs northward to Great Slave Lake, chiefly in the Paleozoic country. Noted in Fl. Bor.-Am. as occurring at Great Bear Lake. — Lower Athabaska (Elk) R., *Kennicott* (N). Lake Athabaska: Shelter Pt., no. 447; muskeg N. W. of Cornwall Bay, no. 6515. Great Slave L.: *Onion, Kennicott & Hardisty* (N); N. W. shore, *Bedford* (O).

Habenaria obtusata (Pursh) Richardson. — *Lysiella obtusata* (Pursh) Rydb. — Abundant in rich woods and timbered muskegs northward to Great Slave Lake, and known also at Great Bear Lake (*J. M. Bell,* O). — Calumet, Athabaska R., no. 457. Lake Athabaska: Shelter Pt., no. 455; Charlot Pt., no. 6226; muskeg S. of Wabba L., no. 6487. Fort Smith and vicinity, no. 451; and *Miss E. Taylor* (G, N, O); lower Slave R., no. 449. Great Slave L.: Resolution, *Kennicott* (N); Keith Isl., no. 456; Maufelly Pt., no. 448; Fairchild Pt.,.nos. 452, 453, 454; Yellowknife Bay, no. 450; N. W. shore, *Bedford* (O); Windy Pt., *Hume,* no. 102658(O); S. W. and N. shores, *Howe,* no. 91984(O).

Spiranthes Romanzoffiana Cham. — *Ibidium Romanzoffianum* (Cham.) House. — Occasional or common in timbered muskegs northward to Great Slave Lake, and noted in Fl. Bor.-Am. at Fort Frank-

lin. — Lower Athabaska (Elk) R., *Kennicott* (N). Lake Athabaska: Shelter Pt., no. 466; near Sand Pt., no. 4535; N. of Cornwall Bay, no. 6479; muskeg N. W. of Cornwall Bay, no. 6527; about 5 mi. S. E. of Wolverine Pt., no. 6815. Upper Slave R. lowland, no. 2073; near upper Smith Rapids, no. 465. Great Slave L.: *R. Bell*, no. 23155(O); *Onion, Kennicott & Hardisty* (N); Maufelly Pt., no. 462; Fairchild Pt., nos. 463, 464; Ft. Rae, *Russell* (O).

Goodyera repens (L.) R. Br. var. **ophioides** Fern. — *Peramium ophioides* (Fern.) Rydb. — *Epipactis repens* (L.) Crantz var. *ophioides* (Fern.) A. A. Eat. — See Contr. Arn. Arb. **6:** 141 (1934). — Noted in Fl. Bor.-Am. as occurring northward to Fort Franklin, but the writer has seen no specimens from beyond the Wood Buffalo Park where it is rare or occasional in rich woods. On sandy beach ridges about Lake Athabaska, however, it becomes exceedingly abundant, particularly on the south shore. — Lake Athabaska: Shelter Pt., no. 467; Sand Pt., nos. 4476, 4559; Cornwall Bay, no. 6635; about 2 mi. E. of Wolverine Pt., no. 6796; about 2 mi. W. Ennuyeuse Cr., no. 6935.

Listera borealis Morong. — *Ophrys borealis* (Morong) Rydb. — Rare or occasional in timbered muskegs northward in the Paleozoic and younger country to the upper Mackenzie (*Kennicott?*, N). — Calumet, Athabaska R., no. 459; Ft. Smith, no. 460; and *Miss E. Taylor* (N, O).

Calypso bulbosa (L.) Oakes. — *C. borealis* Salisb. — *Cytherea bulbosa* (L.) House. — Common to abundant in the pre-Cambrian country northward to Great Bear Lake, but rather occasional in the Paleozoic regions. It grows in rich woods and thickets. — Along the Firebag R. near its mouth, no. 6016. Lake Athabaska: Chipewyan, *Miss E. Taylor* (O); Charlot Pt., no. 6082; Turnor Pt., no. 6842. Great Slave L.: Resolution, *Kennicott* (N); Fairchild Pt., no. 461. "Between Forts Simpson and Chipewyan," *Richardson* (O).

Corallorrhiza trifida Chat. — *C. Corallorrhiza* (L.) Karst. — Occasional in rich woods and timbered muskegs northward at least to Great Slave Lake. — Along Firebag R. near its mouth, no. 6019. Lake Athabaska: Charlot Pt., nos. 6107, 6158; hills N. W. of Cornwall Bay, no. 6528. East shore of L. Mamawi, no. 2037; Forth Smith district, *Miss E. Taylor* (G, O). Great Slave L.: Resolution, *Kennicott* (N); Fairchild Pt., nos. 472, 473.

SALICACEAE

Populus tremuloides Michx. — Common to abundant throughout the forested region nearly to timber line, mainly on dry upland soils. About the eastern arm of Great Slave Lake it is a gnarled and twisted shrub, but farther south, as in the Wood Buffalo Park, it is a large tree

often forming nearly pure stands in burned-over country. — Calumet, Athabaska R., no. 485. Lake Athabaska: Shelter Pt., nos. 483, 484; Charlot Pt., no. 6212; sand hills about 4 mi. S. E. of Wolverine Pt., no. 6787. Upper Slave R. lowland, no. 482; Ft. Smith, no. 489. Great Slave L., Taltheilei Narrows, no. 487.

Populus tacamahacca Miller. — *P. balsamifera* DuRoi, not L. — See Jour. Arn. Arb. **10:** 55 (1929). — Abundant on the great river flood plains throughout the wooded districts. Northeastward it extends as a stunted tree nearly to timber line, occupying sandy or gravelly lake beaches. In the uplands of the Wood Buffalo Park it is associated with the aspen in burned-over areas, forming part of the transition timber between aspen and spruce. — Calumet, Athabaska R., no. 490. Lake Athabaska: Shelter Pt., no. 491; Charlot Pt., no. 6212; bank of Archibald R. near its mouth, no. 6766. Peace R. delta, nos. 493, 494; upper Slave R. lowland, no. 495; Ft. Smith, no. 497. Great Slave L.: Resolution, *J. W. Tyrrell,* no. 23132(O); Fairchild Pt., no. 492; Ft. Reliance, no. 496; N. W. shore, *Bedford* (O). Artillery L., *J. W. Tyrrell* (O).

Salix serissima Fern. — Known in the Mackenzie basin from two collections, one near Lesser Slave Lake (*Brinkman*), and the other from the north shore of Lake Athabaska. The latter was found with nearly mature aments in the last week of June, whereas *S. serissima* of the eastern part of the continent is known for its late flowering — "late August-October." In morphological characters, however, it seems a good match for typical *S. serissima.* See note under *S. lasiandra.* — Charlot R., near its entrance to Lake Athabaska, no. 6353.

Salix lasiandra Benth. — See Jour. Arnold Arb. **1:** 14–20 (1919); Bot. Gaz. **72:** 220–36 (1921); Can. Field Nat. **40:** 145–50 (1926). — Rather common in the lowland flood plain and delta districts northward to the upper Mackenzie (*Dutilly,* G), with a very short extension into the pre-Cambrian country on Lake Athabaska where it grows on damp sandy lake beaches. It was noted in Fl. Bor.-Am. (under *S. lucida*) as reaching northward to Fort Franklin. Flowers collected early in June and mature fruit in August.

The writer has already discussed part of this material in its relation to *S. serissima* Fern. (Contr. Arnold Arb. **6:** 142–3). Most of it appears to be good *lasiandra,* but certain specimens from the east shore of Lake Mamawi seem intermediate between the two. Ball has cited certain Laing specimens from the Athabaska delta under *S. caudata* (*S. lasiandra* var. *caudata* Sudw.), and a Kennicott specimen from the Slave River under *S. serissima.* The writer has been unable to distinguish var. *caudata* in any of his own material, and Ball was apparently doubt-

ful about the Laing specimens due to their immaturity. Consequently these citations have been placed here provisionally, as well as those questionably determined as *S. serissima*. — Grand Rapids, Athabaska R., *Harper,* no. 99036(O); along lower Firebag R., near its mouth, nos. 6029, 6030, 6031; Athabaska delta, main branch, *Laing,* nos. 33, 51 (Herb. Ball, and W.) (N. E.[1]). Lake Athabaska: Shelter Pt., nos. 559, 4448; Sand Pt., no. 4581. East shore of L. Mamawi, nos. 2084, 4406; upper Slave R. lowland, no. 560; Slave R., *Kennicott* (W) (N. E.).

SALIX FRAGILIS L. — An introduced species known only in the southern part of the Mackenzie basin. — Bank of Athabaska R. at Athabaska Landing, *Ball,* no. 116493(O).

Salix interior Rowlee. — See Can. Field Nat. **40:** 174–5 (1926). — Most of the collections of the sand bar willow from our region seem to fall into the narrow-leaved variety *pedicellata,* but occasionally the typical form appears. Thus far it is known only from the Slave River lowland. — Lower delta of Slave R., no. 561.

Salix interior Rowlee var. **pedicellata** (Anders.) Ball. — *S. linearifolia* Rydb. — See Bot. Gaz. **67:** 344 (1919), and Can. Field Nat. **40:** 175 (1926). — Abundant on sand bars in the great river lowlands northward to Great Slave Lake, and probably also to the Mackenzie. — Calumet, Athabaska R., no. 562; along the Firebag R. near its mouth, no. 6012; delta of Athabaska R., no. 566; and *Harper,* no. 99035(O); Sand Pt., L. Athabaska, no. 4563; E. shore of L. Mamawi, no. 2086; delta of Peace R., nos. 564, 565; upper Slave R. lowland, no. 563; lower Slave R., near Grande Detour, *Harper,* nos. 99019, 99025(O); Slave R., *Kennicott* (N); between Forts Simpson and Chipewyan, *Richardson* (O) (*S. longifolia* of Fl. Bor.-Am. and Macoun's Cat., at least in part). — In his revision of this group (Can. Field Nat. loc. cit.) Ball cites the following specimens not thus far examined by the writer. Under *S. interior;* Ft. McMurray, *E. A. and A. E. Preble,* no. 81; and under var. *pedicellata*: Athabaska delta, *Laing, nos.* 42, 49 (Herb. Ball).

Salix reticulata L. — An arctic species which enters our region only in exposed situations not far from the timber line. — Great Slave L.: Taltheilei Narrows, no. 572; Maufelly Pt., no. 571; Fairchild Pt., no.

[1]During the time this study has been in progress a considerable number of northern specimens of *Salix* have been away from Herb. O. on loan, and consequently have not been seen by the writer. In most cases it has seemed advisable to include these as well as a few citations of Schneider and Ball material for future reference, and wherever they have been inserted the letters "N. E." (not examined) immediately follow. It should be noted that most of the determinations of such specimens are those of either Schneider or Ball, both recent students of American willows who have had access to the collection.

570; Caribou Isl., *Seton & Preble*, no. 78303(O) (N. E.). Artillery L., *Seton & Preble*, no. 78304(O) (N. E.).

Salix arctica Pallas. — See Bot. Gaz. **66:** 118 (1918). — A northwestern arctic species apparently rare in our region, and known only in the pre-Cambrian country. The Chipewyan specimen was found in good fruit sometime between June 17 and July 21, presumably soon after the first date. — Chipewyan, L. Athabaska, *Dutilly*, no. 148(G); Artillery L., *J. W. Tyrrell*, no. 23120(O) (N. E.).

Salix arctophila Cock. — *S. groenlandica* Lundström. — See Bot. Gaz. **66:** 140 (1918), and **67:** 57 (1919). — Occasional on exposed shores at least in the northern part of the pre-Cambrian country. — North shore of McLeod Bay, Great Slave L., nos. 546, 547. The following specimens are cited here provisionally, since the group to which they belong is notably difficult: N. shore of L. Athabaska, *J. W. Tyrrell*, no. 1703(O) (N. E., probably *S. Brownii* of Tyrrell's list); Ft. Resolution, *J. W. Tyrrell*, no. 23128(O) (N. E.); Artillery L., *J. W. Tyrrell*, no. 23127(O) (N. E., probably *S. Brownii* of Tyrrell's list), and *Seton & Preble*, no. 78301(O) (N. E.).

Salix brachycarpa Nutt. var. **antimima** (Schn.) Raup. — See Rhod. **33:** 241–4 (1931). — Known in the Mackenzie basin east of the mountains only in the Wood Buffalo Park.

Salix brachycarpa Nutt. var. **psammophila**, var. nov. PLATE 191[1]

A *S. brachycarpa* differt habitu stricto erecto (9–12 dm. alto), foliis late ovatis (rarius obovatis), plerisque 1 × 2 cm., basi rotundatis ad subcordatis, dense albo-sericeis.

Among inland shifting sand dunes south of William Pt., south shore of Lake Athabaska, Sask., Aug. 16, 1935, no. 6888 (Type, A). Another number (no. 6902) which matches the type was collected in the same dune area, about 4 miles farther west, on Aug. 20, 1935.

This material, with its woolly, nearly sessile capsules, short styles, pale bracts, and aments borne on leafy peduncles, clearly belongs to the group of polymorphic and largely intergrading species centering about the circumpolar *S. glauca* L. Within this group it is closely related to the predominantly western American complex distinguished by its short, ovate-oblong to nearly spherical aments, for which the oldest name is *S. brachycarpa* Nuttall. Nothing in this complex, however (*S. pseudolapponicum* v. Seeman, *S. brachycarpa* var. *antimima* (Schn.) Raup, *S.*

[1]PLATE 191. *Salix brachycarpa* Nutt. var. *psammophila* Raup. Details are part of type collection from sand dunes about 5 miles south of William Pt., Lake Athabaska, no. 6888; detail of ament × 2; habit photo taken on same dune area, just east of Ennuyeuse Creek, August 20, 1935.

niphoclada Rydb., etc.), has the broadly ovate leaves or strict, upright habit of our plants. Certain eastern representatives of the group collected on Mt. Albert in the Gaspé region (Fernald & Collins, nos. 65 and 513, distributed as *S. desertorum* var. *stricta*) show a tendency toward broad leaves on young shoots, but the tendency is not consistent, nor are the leaves so heavily clothed with long hairs, and the plants are low, depressed shrubs like most of the relatives of *S. brachycarpa*.

Salix desertorum Richards. — See Rhod. **33:** 241–4 (1931). — Apparently rare, and confined to exposed situations near timber line or in the scrubby woodlands of the pre-Cambrian regions. It is the writer's opinion that *S. desertorum* may be only a dwarfed form of the woodland *S. glauca* growing in bleak, exposed situations or cold upland bogs. — Taltheilei Narrows, Great Slave L., no. 534. — Schneider (Bot. Gaz. **66:** 340) provisionally referred to this species a specimen collected on Artillery Lake by *Seton & Preble*, no. 78300(O) (N. E.). This appears to have been originally determined *S. niphoclada* Rydb. by J. M. Macoun and later verified as such by Ball. Another *Tyrrell* specimen may also be placed here provisionally: Lake Athabaska, *J. W. Tyrrell*, no. 1710(O) (N. E.).

Salix MacCalliana Rowlee. — Common in parts of the Wood Buffalo Park, especially on the Salt Plain, but not known elsewhere in our region.

Salix Tyrrellii, sp. nov. PLATE 192[1]

Frutex patulus, ad 2 m. altus, cortice rubescente lucido, ramulis rubescentibus glabris etiam novellis; folia matura 2–3.5 cm. longa, 4–8 mm. lata, lanceolata ad elliptica, rarius oblanceolata, basi acuta, apice acuta ad acuminata, utrinque nitido-viridia, saepe supra lucida, paulo coriacea, inaequaliter et minute sed conspicue serrata dentibus glandulosis plerumque 2–3 per 5 mm., rarius 4 per 5 mm.; petioli 2–6 mm. longi, basi rubescentes; stipulae non persistentes, rubescentes, ovatae ad lanceolatae, serratae, acutae, 1–2 mm. longae. Amenta feminea (immatura) 1–2.5 cm. longa, circa 8 mm. lata, pedunculo brevi foliato suffulta; capsula dense albo-hirsuta, 3–4 mm. longa, fere sessilia vel pedicello quam 1 mm. breviore; styli 2–2.5 mm. longi, rubro-fulvi, stigmatibus circa 3 mm. longis bifidis; bracteae circa 3 mm. longae, basi 0.5 mm. latae, anguste lanceolatae, acutae, basi rubro-fulvae apicem versus flavescentes, albo-hirsuto-pubescentes, apice glabratae, venosae; glandula (immatura tandem) ventralis tantum adest, ut videtur e glandulis

[1]PLATE 192. *Salix Tyrrellii* Raup. Part of type collection from shifting sand dunes about 5 miles south of William Pt., Lake Athabaska, no. 6887; details of leaf and ament × 2.

binis parvis paulo supra basin pedicelli insertis composita.

Among inland shifting sand dunes south of William Pt., south shore of Lake Athabaska, Sask., Aug. 16, 1935, no. 6887 (Type, A). A sterile specimen, no. 6903, was collected from the same dune area, but about 4 miles farther west, on Aug. 20, 1935.

With its pubescent, short-pedicelled capsules, long, reddish to yellowish bracts, divided stigmas, and aments borne on short leafy peduncles, *S. Tyrrellii* evidently belongs to the section GLAUCAE of Fries, but beyond these characters the relationship does not go, with a possible exception in the case of *S. MacCalliana* Rowlee. This anomolous species also possesses entirely glabrous, distinctly serrate leaves, but has ament characters which clearly relate it to *S. glauca*. The leaves of *S. MacCalliana* are rather bluish-green, and tend to be crenate-dentate, and commonly 6 or more cm. long, whereas in our plant they are much smaller, bright green, with salient glandular teeth which are fewer in number than in *S. MacCalliana* (usually 2–3 per 5 mm., as against 3–4 per 5 mm.). The apex is consistently acute or acuminate, rather than subacute as in *S. MacCalliana*, and the leaves are but rarely oblanceolate, while they are commonly so in the latter species. In our plant the styles are 2–2.5 mm. long, while in *S. MacCalliana* they are 0.8–1.3 mm. long. *Salix Tyrrellii* is named for the distinguished Canadian geologist, J. W. Tyrrell, who, in 1893, made the first notable plant collections from Lake Athabaska.

Salix glauca L. — See Rhod. **33**: 241 4 (1931). — Rather common throughout most of the region, growing in muskeg thickets and open muskeg timber, or at the borders of rich woods. It varies widely in leaf form and pubescence, and in the form and size of the shrub, but its division into more than one specific entity seems unjustifiable. Of the specimens cited below, nos. 6461, 6462, 6463 are especially notable because of their short broad leaves which somewhat resemble those of *S. cordifolia*. The latter is not thus far known in the Mackenzie basin. — Lake Athabaska: Shelter Pt., nos. 523, 4420; Camsell Portage, nos. 6178, 6181, 6184, 6185, 6186, 6196; along Charlot R., near its entrance to L. Athabaska, no. 6354; near base of Cornwall Bay, nos. 6459, 6461, 6462, 6463, 6513, 6514. Rocher R., below L. Athabaska, *Harper*, no. 99037(O); upper Slave R. lowland, no. 6129. Great Slave L.: Taltheilei Narrows, no. 521; Fairchild Pt., no. 524; N. W. shore ?, *Bedford* (O).

Salix glauca L. var. **acutifolia** Schn. — See Bot. Gaz. **66**: 327 (1918), and **67**: 60 (1919); Rhod. **33**: 241–4 (1931). — Common in muskegs and on damp lake shores in the pre-Cambrian parts of our region, but known also from Great Bear Lake and the Mackenzie River

(*Richardson,* N). — Lake Athabaska: near Sand Pt., nos. 4507, 4517, 4518, 4528; Camsell Portage, no. 6182; Charlot Pt., nos. 6223, 6297; along Charlot R. near its mouth, nos. 6355, 6356, 6357; near base of Cornwall Bay, nos. 6458, 6459-a, 6460, 6569. Great Slave L.: near Caribou Isl., *Seton & Preble,* no. 78305(O) (N. E.; *S. atra* of Seton's list; placed here provisionally by Schneider); Fairchild Pt., nos. 576?, 528, 532, 533; Maufelly Pt., no. 531; Yellowknife Bay, no. 530.

Salix glauca L. var. **poliophila** (Schn.), status nov. — In his monographic studies of American willows, Schneider described a forma *poliophylla* of *Salix glauca* L. var. *acutifolia* Schn. (Bot. Gaz. **67:** 60–61). His remarks are as follows: "There are before me several specimens collected at Great Slave Lake, Mackenzie, which, in my opinion, are most closely related to var. *acutifolia,* but at least some of them seem to represent a very villous form of it, for which I propose the name: S. GLAUCA var. ACUTIFOLIA f. **poliophylla,** forma nov. — A typo nonnisi differre videtur ramis annotinis densius villoso-lanuginosis etiam vetustioribus tomento lanuginoso pl.m. obtectis, foliis superne pl.m. laxe adpresse sericeo-lanuginosis subtus villo densissimo molli pl.m. adpresso albo vestitis. The type is Great Slave Lake, Fort Rae, July 28, 1901, *E. A.* and *A. E. Preble* (no. 139, fr.; W.; folia inferiora elliptica vel oblongo-elliptica, utrinque acuta, superiora magis ovato-elliptica apice acutiora, maxima ad 5: 2.2 cm. magna; amenta fructifera pedunculo foliato ad 3 cm. longo excluso ad 5: 1.3 cm. magna; fructus e basi rhomboideo ovoideo-conici, ad 9 mm. longi pedicello ad 1.5 mm. longo glandulam subduplo superante excluso)." Schneider cited some other Preble specimens as intermediate between this form and typical var. *acutifolia*: Ft. Resolution, no. 141 and no. 194, Ft. Good Hope, Mackenzie R., nos. 330 and 332. The writer has not seen the Preble specimens, but there is a good photograph of the type of f. *poliophylla* in the Herbarium of the Arnold Arboretum. It is matched very well by the writer's no. 503, collected at Yellowknife Bay, Aug. 22, 1927. Other material collected in 1932 near Sand Pt., Lake Athabaska, shows the same tendency to be extremely villous on leaves and twigs (nos. 4508, 4597), and is evidently closely related to the Great Slave Lake plants. The same is true of a specimen collected at the eastern end of Lake Athabaska in 1935 by R. S. Campbell, no. 132395(O). With the more abundant material now at hand, therefore, the form seems worthy of being considered as a variety having a distinct geographic affinity in the central part of the Mackenzie basin.

Salix Mackenzieana Barratt. — See Jour. Arn. Arb. **2:** 190 (1921). — Occasional on gravel bars and local river flood plain deposits

along the major streams, northward to the Mackenzie (*Richardson,* G), but not known in the pre-Cambrian country. — Island in Slave R. below Grande Detour, *Harper,* no. 99026(O); Great Slave L.? *Richardson* (G).

Salix lutea Nutt. — Abundant on the upper parts of local flood plain deposits in the great river lowlands northward at least to the Slave River. — Along the Quatre Fourches R., in the lower Peace delta, nos. 555, 558; upper Slave R. lowland, no. 554; lower Slave R., no. 557.

Salix Turnorii, sp. nov. PLATE 193[1]

Frutex 1.8–3 m. altus, habitu erecto stricto; cortex pallide cinerascens, ramulis novellis rubris exceptis; ramuli novelli tenuiter pubescentes, ceterum rami glabri; folia matura lanceolata, elliptica, vel oblanceolata, basi acuta vel leviter rotundata, apice acuta ad acuminata, 2–3.5 cm. longa (pleraque 2.5–3 cm.) 6–10 mm. lata (pleraque 7–8 mm.), utrinque pallide viridia, subtus paulo pallidiora, modice reticulata, paulo firma et coriacea, subtiliter et aequaliter glanduloso-serrata, glandulis rubescentibus leviter incurvis, novella subtus sericea mox glabrescentia; petioli 2–5 mm. longi, glabri novellis exceptis, rubri; stipulae 1–5 mm. longae, ovatae, obtusae ad acutae, glanduloso-serratae, colore foliis similes, persistentes. Amenta feminea 1–3 cm. longa, 1–1.5 cm. lata, pedunculo brevi foliato suffulta; capsula circa 5 mm. longa, rostrata, glabra, rubescenti-brunnea, pedicellis glabris rubescenti-brunneis circa 2–3 mm. longis suffulta; styli 0.5 mm. longi, indivisi, stigmatibus subcapitatis; bracteae anguste lineares vel lineari-lanceolatae, pedicello triente breviores, glabrae vel paulo pubescentes, rubescenti-brunneae, persistentes; glandula truncata, lanceolata ad linearis, circa 0.5 mm. longa; rachis cinereo-pubescens.

Among inland shifting sand dunes south of William Point, south shore of Lake Athabaska, Sask., Aug. 16, 1935, no. 6885 (Type, A). Another number (6908) collected from the same dune region, but about 4 miles west, on Aug. 20, 1935, is identical with the type number.

This willow seems most closely related to *S. cordata* or *S. lutea,* in the section CORDATAE of Barratt. Its combination of small, regularly glandular-serrate leaves, bright red new twigs, gray-green older twigs and bark, and its striking upright, rather narrowly pyramidal habit clearly distinguish it from these species or their close relatives. In leaf and twig characters it suggests somewhat certain forms of *S. Goodingii* Ball,

[1]PLATE 193. *Salix Turnorii* Raup. Details are part of type number collected on shifting dunes about 5 miles south of William Pt., Lake Athabaska, no. 6885; details of aments × 2; habit photo taken on the same dune area, just east of Ennuyeuse Creek, August 20, 1935.

in the section NIGRAE, or forms of *S. amygdaloides* Andersson, in the TRIANDRAE, but its persistent reddish-brown scales separate it from either of these groups. It is named for Philip Turnor, a pioneer geographer who, while in the employ of the Hudson's Bay Company in 1791, made a surprisingly comprehensive and accurate map of Lake Athabaska and connecting waterways.

Salix Farrae Ball. — See Contr. U. S. Nat. Herb. **22:** 321 (1921) and Univ. Calif. Pub. in Bot. **17:** 406–9 (1934). — Apparently rare in our region, and known only in the southwestern part of the Wood Buffalo Park where it grows in muskeg thickets in the Caribou Mts.

Salix myrtillifolia Anders. — See Jour. Arn. Arb. **2:** 193 (1921). — An abundant species in timbered muskegs northward to Great Bear Lake (*Richardson,* G, N) and the Mackenzie (*Preble*). Tyrrell noted it on Artillery Lake just at the edge of the timber. — Clearwater R., *J. M. Macoun,* no. 18854(O) (N. E.). Lake Athabaska: near Sand Pt., no. 4637; Camsell Portage, nos. 6176, 6177, 6198, 6199; Charlot Pt., no. 6298. Upper Slave R. lowland, no. 516; Tazin R., N. of L. Athabaska, *Harper,* no. 99024(O). Great Slave L.: Caribou Isl., *Seton & Preble,* no. 78306(O) (N. E.); Taltheilei Narrows, no. 519; Fairchild Pt., nos. 517, 518, 520. E. A. Preble cited material in his list from Resolution, but this has not been seen by the writer.

Salix pseudomonticola Ball. — See Contr. U. S. Nat. Herb. **22:** 321 (1921) and Jour. Arn. Arb. **3:** 73 (1921). — Apparently occasional in the fringe of timber along pond and lake shores in the Wood Buffalo Park and southwestward. Most of the material collected thus far is scanty, and the species needs further study in our region. — Athabaska Landing, *Ball,* no. 2362(O).

Salix pyrifolia Anders. — *S. balsamifera* Barratt. — See Jour. Arn. Arb. **1:** 168 (1920). — Occasional at muskeg and slough margins northward to the Lake Athabaska district and the Wood Buffalo Park. It appears to be commonest in the pre-Cambrian country. — Lower Athabaska (Elk) R., *Kennicott* (N). Lake Athabaska: Shelter Pt., nos. 573, 574, 575, 4456, 4459; near Sand Pt., no. 4596; Camsell Portage, no. 6183; 5 mi. E. of Poplar Pt., nos. 6664, 6677; along William R. near its mouth, no. 6874; 2 mi. W. of Ennuyeuse Cr., no. 6945. Hill Island L., *Harper,* no. 99021(O).

Salix alaxensis (Anders.) Cov. — See Jour. Arn. Arb. **1:** 223 (1920), Contr. Arn. Arb. **6:** 147–9 (1934). — A northwestern arctic and alpine species which reaches our region on Great Slave Lake, where it inhabits sandy and gravelly shores. — Great Slave L.: Caribou Isl., *Seton & Preble,* no. 78302(O) (N. E.); Taltheilei Narrows, no. 502;

Fairchild Pt., nos. 500, 501, 504; Ft. Reliance, no. 499; N. W. shore, *Bedford* (O).

Salix silicicola, sp. nov. PLATE 194[1]

Frutex erectus ramis patulis, 1.2–3 m. altus; cortex rubescenti-brunneus; ramuli dense albo-pilosi vel albo-tomentosi, tomento diu persistente; folia matura integerrima, late elliptica ad obovata, pleraque obovata, basi rotundata vel leviter cuneata, apice pleraque obtusa vel rotundata et leviter mucronata, sed aliquando acuta, 3–6 cm. longa, 2–3.5 cm. lata, conspicue reticulata, utrinque lana crassa alba sericante dense vestita, supra cinerea ad pallide viridia, infra alba; petioli 2–10 mm. longi, albo-piloso-tomentosi, aliquando alati; stipulae late ovatae ad lanceolatae, obtusae vel acutae, 3–7 mm. longae, aliquando tenuiter glanduloso-serratae, piloso-tomentosae ut petioli et folia, persistentes. Amenta feminea sessilia, 2–7 cm. longa, dense florifera, matura circa 1 cm. lata; capsula pilosa, circa 6 mm. longa, 2–3 mm. lata, sessilis vel pedicello quam 1 mm. brevior; bracteae late ovatae, 2–2.3 mm. longae, basi rubro-fulvae apicem versus nigrescentes, obtusae vel acutae, pilis albis quam bracteae 2-plo vel ultra longioribus; styli 2–2.5 mm. longi, apice ad quartam partem bifidi, stigmatibus linearibus; glandula unica ventralis oblonga, rubro-fulva, 0.5–1 mm. longa, 0.2–0.3 mm. lata, indivisa. — Sandy beach ridges just east Wolverine Pt., south shore of Lake Athabaska, Sask., July 28, 1935, no. 6704 (Type, A). Two other numbers collected on the south side of Lake Athabaska match the type material. No. 6907 was secured on the shifting dunes south of William Pt. on August 20, and no. 6952 was collected on the sandy shore of the lake just west of Ennuyeuse Cr., on Aug. 22.

Salix silicicola is one of the most attractive willows of the Mackenzie basin, and is made conspicuous against the dark greens of the conifers by its nearly white leaves and twigs. It clearly belongs to the section *Chrysantheae* of Koch, which contains also *S. Hookeriana, S. laurentiana, S. alaxensis,* and *S. Barrattiana.* Of these it is most nearly related to the typical forms of *S. alaxensis,* which it resembles in habit, in the general shape of its leaves and aments, and in its long styles. It differs notably from *S. alaxensis,* however, in having stipules shorter (up to 7 mm. long as against 22 mm.) broadly ovate to lanceolate rather than linear-lanceolate to filiform, and in having a persistent, heavy, hirsute-

[1]PLATE 194. *Salix silicicola* Raup. Details are part of type number collected on sandy beach ridges just east of Wolverine Pt., Lake Athabaska, no. 6704; habit photo taken among shifting sand dunes just east of Ennuyeuse Creek, August 20, 1935.

tomentose covering on both sides of the leaves instead of having the leaves glabrate or quite glabrous and bright green above. Further, its leaves are consistently broader than those of *S. alaxensis*, as well as more strongly obovate and obtuse.

Salix candida Flügge. — Occasional or common in muskeg thickets northward in the Paleozoic and younger country at least to Great Slave Lake. Noted in Fl. Bor.-Am. as occurring "throughout the woody country," but the writer has seen no material from north of those cited below. — Slave R., *Richardson* (O); low island 3 mi. W. of Rocher R., Great Slave L., *Harper*, no. 99014(O); Great Slave L., *Seton & Preble*, no. 78307(O) (N. E.).

Salix Bebbiana Sarg. — *S. rostrata* Richards., not Thuill. — This is probably the most abundant willow in our region, and is known far northward to Great Bear Lake and the lower Mackenzie (*Richardson*, N; *McConnell*, O). It commonly grows to a height of 15 or 20 feet, and is the most important constituent of the small tree and shrub layer in nearly all of the woodlands of the Wood Buffalo Park and southward. It is most common in young river bottom timber and upland aspen woods. Eastward in the pre-Cambrian country it commonly grows on sandy and gravelly lake shores. Both Rydberg and Schneider regarded Richardson specimens cited below, and originally labeled *S. rostrata*, as part of the type material of the species. Schneider has kept up var. *perrostrata* (*S. perrostrata* Rydb.) for some of the glabrescent leaved forms of the species, and has referred some of the following specimens to it tentatively. The present writer, however, has been unable to distinguish the variety satisfactorily among Mackenzie basin material. — Lac la Biche, nos. 6009, 6010; Athabaska Landing, *Ball*, no. 2365(O); McMurray, *Dutilly*, no. 116(G); along the Athabaska R., below McKay, no. 6005; Calumet, Athabaska R., nos. 543, 544; along the Firebag R. near its mouth, nos. 6048, 6049. Lake Athabaska: Sand Pt., no. 4657; Charlot Pt., nos. 6145, 6146, 6262; N. shore, *J. W. Tyrrell*, no. 1766(O); 5 mi. E. of Poplar Pt., no. 6683; near Wolverine Pt., no. 6716. Delta of Peace R. (Quatre Fourches R.), nos. 540, 542; E. shore of L. Mamawi, nos. 2107, 2108; upper Slave R. lowland, nos. 539, 2111; Ft. Smith, nos. 538, 2118; and *Seton & Preble*, nos. 78311, 78312, 78309, 78310(O); Slave R., *Kennicott* (N). Tazin R. above Great Falls, *Harper*, no. 99031(O); junction of Telon and Tazin R.'s, *Harper*, no. 99028(O); lake on Tazin R., *Harper*, no. 99023(O). Fort Franklin and Portage la Loche (Methye Portage), *Richardson* (N) (apparently *S. fusca* of Fl. Bor.-Am.); between Simpson and Chipewyan, *Richardson* (O) (*C. rostrata* in Fl. Bor.-Am.); between Cumberland

House and Ft. Franklin, *Richardson* (G, N) (*C. rostrata* in Fl. Bor.-Am.). Great Slave L.: Resolution, *Dutilly*, no. 108(G); near Caribou Isl., *Seton & Preble*, no. 78308(O); base of Maufelly Pt., no. 536; Ft. Reliance, no. 545; Yellowknife Bay, no. 537; N. W. shore, *Bedford* (O) (doubtful fragment).

Salix pedicellaris Pursh var. **hypoglauca** Fern. — See Jour. Arn. Arb. **2:** 81–2 (1920). — Occasional in shrubby muskegs northward to Great Bear Lake (*Richardson*, N). On the south side of Lake Athabaska it is common at the margins of sandy ponds. — Professor Fernald has regarded typical *S. pedicellaris* Pursh as a comparatively rare plant with leaves green on both surfaces (Rhod. **11:** 161), an opinion not held by Schneider who grouped all American material with the typical species. Pursh's type is not available, but Schneider regarded the notes on leaf character in its description as inconclusive since it was collected very early in the season (April, in the Catskill Mts.). However, Pursh states also that the species flowered later in a European garden, so that he may well have been familiar with its mature leaves. — Lake Athabaska: near Sand Pt., no. 4507-a; 5 mi. E. of Poplar Pt., no. 6685; about 5 mi. S. E. of Wolverine Pt., no. 6811; 2 mi. W. of Ennuyeuse Cr., no. 6975.

Salix pedicellaris Pursh var. **tenuescens** Fern. — See Rhod. **11:** 162 (1909). — Apparently rare in the Mackenzie basin, and known from a single collection in an upland muskeg thicket in the Wood Buffalo Park.

Salix athabascensis Raup. — See Rhod. **32:** 111 (1930). — Known thus far only from its type locality, an upland muskeg thicket in the Wood Buffalo Park.

Salix petiolaris Sm. — Common at the margins of sloughs and semi-open prairies northward in the Paleozoic and younger country to the Wood Buffalo Park. Tyrrell noted it on the north shore of Lake Athabaska, but no specimen is available. — East shore of L. Mamawi, nos. 2123, 2124, 4405; upper Slave R. lowland, nos. 567, 569; Ft. Smith, no. 568.

Salix Scouleriana Barratt. — See Jour. Arn. Arb. **2:** 6–13 (1920). — A common willow about Lake Athabaska, but apparently unknown elsewhere in the Mackenzie basin east of the mountains. It usually grows on gravelly or sandy lake beaches, or on rather dry upland sand plains. Certain specimens collected at Charlot Pt. in 1935 (nos. 6151, 6154, 6155, 6161) seem to approach *S. planifolia* in leaf characters. — Lake Athabaska: Shelter Pt., nos. 525, 526, 527, 4450; Sand Pt., no. 4468; Charlot Pt., nos. 6150, 6151, 6154, 6155, 6161, 6263;

near base of Cornwall Bay, no. 6599; 5 mi. E. of Poplar Pt., no. 6663; about 4 mi. S. E. of Wolverine Pt., nos. 6750, 6781; shifting sand dunes S. of William Pt., no. 6886 (forma *poikila* Schn.).

Salix planifolia Pursh. — *S. chlorophylla* Anders. — Abundant at slough and prairie margins, and on local river flood plains throughout most of the wooded country northward to Great Slave Lake, and known from Great Bear Lake (*Richardson,* N) and the lower Mackenzie (*Preble*). It is common in the pre-Cambrian country about Lake Athabaska, but has not been collected on the eastern arm of Great Slave Lake. — Grand Rapids, Athabaska R., *Harper,* no. 99017(O); Calumet, Athabaska R., no. 508; along Firebag R. near its mouth, nos. 6022, 6027, 6028. Lake Athabaska: Shelter Pt., nos. 506, 507, 509, 510, 4458, 4459-a; Sand Pt. and vicinity, nos. 4539, 4580, 4658; near Fishing R., no. 6077; Charlot Pt., nos. 6147, 6148; Camsell Portage, nos. 6179, 6180, 6193; near base of Cornwall Bay, nos. 6489, 6631; 5 mi. E. of Poplar Pt., no. 6686; near Wolverine Pt., no. 6794; along William R. near its mouth, no. 6875; about 2 mi. W. of Ennuyeuse Cr., nos. 6944, 6949. East shore of L. Mamawi, nos. 2144, 2145, 2146; lower delta of Peace R., no. 515; upper Slave R. lowland, nos. 513, 2148. Great Slave L.: Resolution, *Preble,* no. 143(W) (N. E.); near Stoney Isl., *Seton & Preble,* no. 78299(O) (N. E.); about 15 mi. E. of Moraine Pt., *Bedford* (O) (doubtful fragment).

Salix Nelsonii Ball. — This species may prove to be only a variety or form of *S. planifolia,* as strongly suggested by Schneider (Jour. Arn. Arb. I. 80–1). It is occasional at upland slough margins west of the upper Slave River.

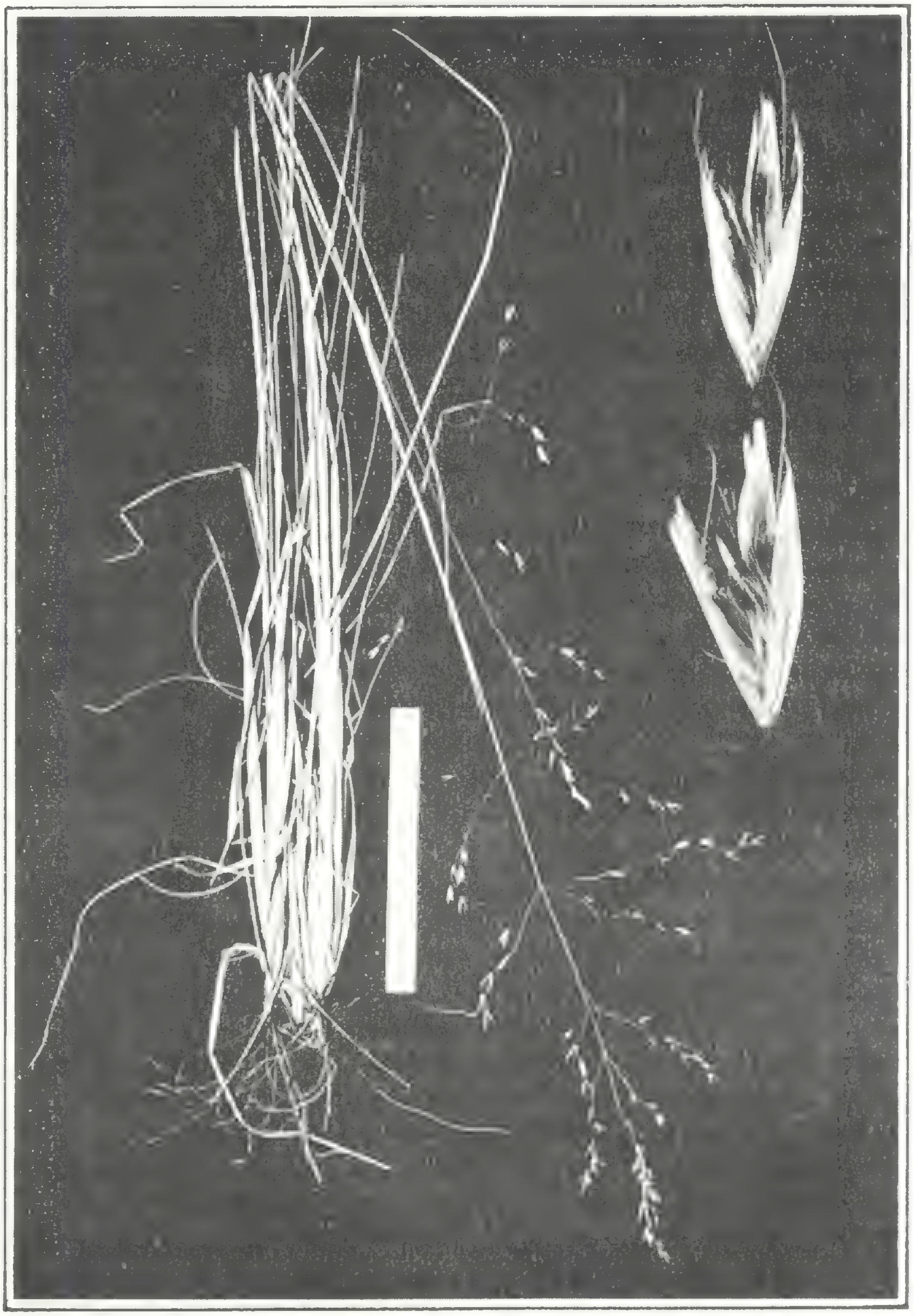
Salix subcoerulea Piper. — A cordilleran species known only in the southern and southwestern parts of the Mackenzie basin. — Athabaska Landing, *Ball,* no. 2364(O).

Salix arbusculoides Anders. — See Jour. Arn. Arb. **2:** 84 (1920). — A common willow of muskeg and slough margins throughout the Paleozoic and younger country. Eastward in the pre-Cambrian it is usually found on damp sandy or rocky shores, and on river flood plains it appears at the margin of the high timber. — Athabaska Landing, *Ball,* no. 116491(O) (N. E.); along the Firebag R. near its mouth, no. 6032. Lake Athabaska: Sand Pt., no. 4509; Charlot Pt., nos. 6152, 6153, 6159. Upper Slave R. lowland, nos. 550, 2097; Ft. Smith, no. 2096; lower Slave R., *Harper,* no. 99027(O). Great Slave L.: Resolution, *Preble,* no. 151(W) (N. E.); Maufelly Pt., no. 543; Fairchild Pt., nos. 529, 549, 551, 552, 553; N. W. shore, *Bedford* (O); Loon Isl., *Preble,* nos. 133, 134 (W) (N. E.).

MYRICACEAE

Myrica Gale L. — Common in the pre-Cambrian country northward to Great Slave Lake, and noted by Richardson and Preble at Ft. Norman and Great Bear Lake, respectively. It appears to be quite rare west of the Slave River. It inhabits swamps and sandy lake shores. — Lake Athabaska: Shelter Pt., nos. 629, 632, 633, 4444; Sand Pt., no. 4652; Camsell Portage, no. 6191; mouth of Charlot R., no. 6310; N. shore, *J. W. Tyrrell*, no. 24056(O); mouth of Archibald R., no. 6769; bank of William R. near its mouth, no. 6872. Great Slave L.: Taltheilei Narrows, no. 627; mouth of Mountain R., no. 631; Fairchild Pt., nos. 628, 630, 635, 636; Yellowknife Bay, no. 634; N. W. shore, *Bedford* (O).

(*To be continued*)



DESCHAMPSIA MACKENZIEANA Raup

FULL-TONE — MERIDEN

SALIX BRACHYCARPA var. PSAMMOPHILA Raup

FULL-TONE — MERIDEN

SALIX TYRELLII Raup

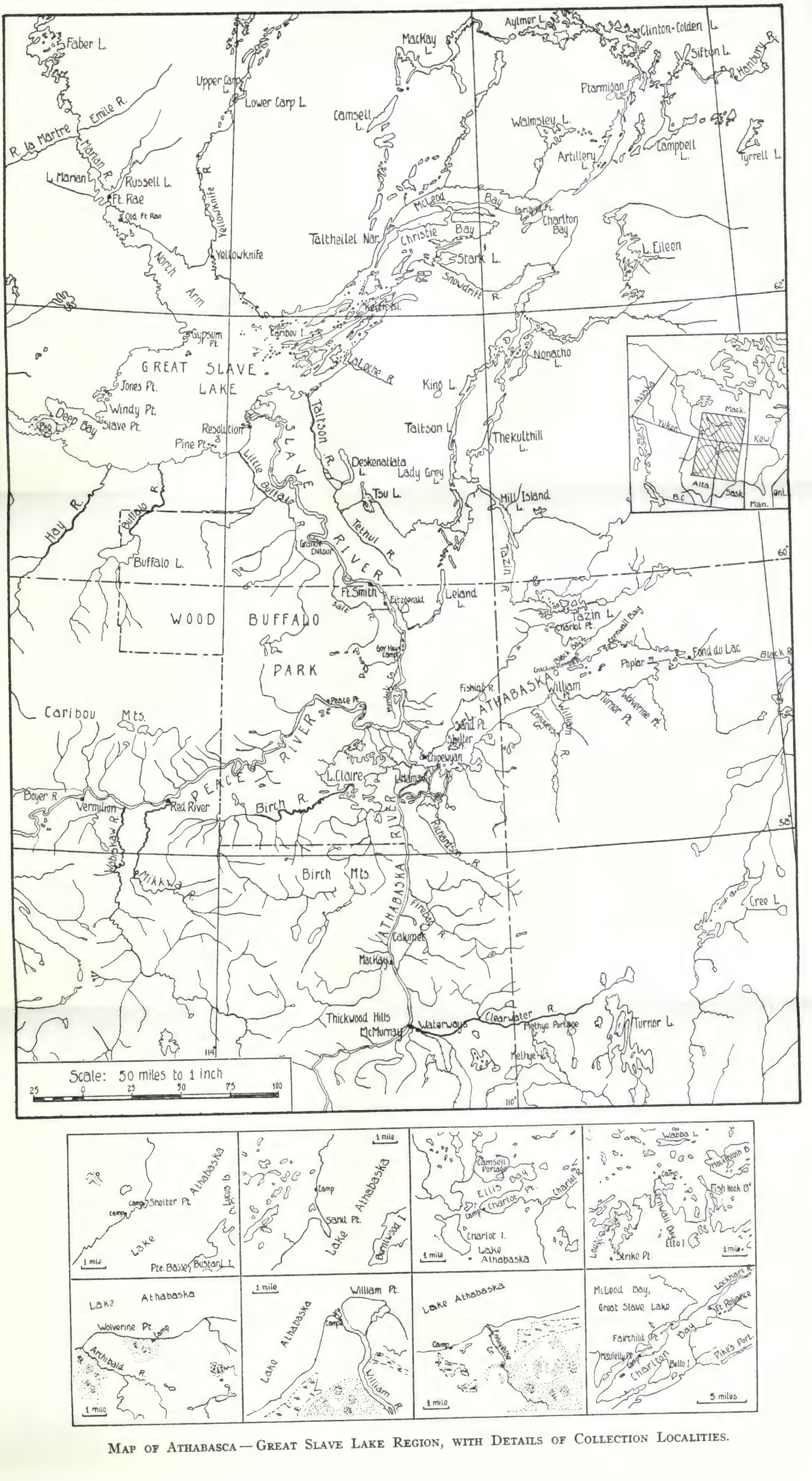
FULL-TONE — MERIDEN

SALIX TURNORII Raup

FULL-TONE — MERIDEN

SALIX SILICICOLA Raup

FULL-TONE — MERIDEN



MAP OF ATHABASCA — GREAT SLAVE LAKE REGION, WITH DETAILS OF COLLECTION LOCALITIES.

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PHYTOGEOGRAPHIC STUDIES IN THE ATHABASKA — GREAT SLAVE LAKE REGION

I. CATALOGUE OF THE VASCULAR PLANTS[1]

HUGH M. RAUP

With plates 195–200

BETULACEAE

Corylus cornuta Marsh. — *C. rostrata* Ait. — Common or occasional in upland woods in the southern part of the region, and not known north of the lower Athabaska. — McMurray, no. 7083; along the Firebag R. near its mouth, no. 6041.

Betula papyrifera Marsh. — Most of the white birches in the Mackenzie basin fall into one or the other of the following varieties, but the typical species is at least occasional on the southern boundaries. — McMurray, no. 7102.

Betula papyrifera Marsh. var. **occidentalis** Sarg. — This is the common form in the mountains of the upper Peace River region, and is also known at Lesser Slave Lake and about Lake Athabaska. On the south shore of the latter it is quite common on old beach ridges. — Lake Athabaska: Charlot Pt., no. 6218; Cornwall Bay, no. 6601; sand dunes on point about 4 mi. E. of Wolverine Pt., no. 6801; in pine-spruce woods near shore about 2 mi. E. of Wolverine Pt., trees about 20 feet high, nos. 6834, 6835, 6836.

Betula papyrifera Marsh. var. **neoalaskana** (Sarg.) Raup. — *B. alascana* Sarg., not Lesquereux. — *B. neoalaskana* Sarg. — See Contr. Arnold Arb. **6:** 152 (1934). — Common to abundant in upland woods throughout the region. The variety is distinguished mainly by its resinous-glandular twigs, and there are many forms which appear transi-

[1]Continued from p. 240.

tional to the non-glandular typical species. But the very glandular forms are much the commonest in our region, and appear to constitute a good geographic variety. Trees 6–10 inches in diameter are usual, but they occasionally reach 12–15 inches in good soils. — Calumet, Athabaska R., no. 598. Lake Athabaska: Shelter Pt., nos. 592, 593, 594, 595, 596, 597, 606, 4463; Sand Pt., nos. 4583, 4585; 5 mi. E. of Poplar Pt., nos. 6656, 6668; 2 mi. E. of Wolverine Pt., no. 6714; gravel dunes just E. of Ennuyeuse Cr., no. 6920; 2 mi. W. of Ennuyeuse Cr., no. 6947. Along Quatre Fourches R., nos. 601, 605; upper Slave R. lowland, no. 2181; lower Slave R., no. 604. Great Slave L.: Taltheilei Narrows, no. 607; Fairchild Pt., nos. 600, 602, 603; Ft. Reliance, no. 591; Yellowknife Bay, no. 599; N. W. shores, *Bedford* (O).

Betula microphylla Bunge. — *B. fontinalis* Sarg. — Rare or occasional, but of wide distribution northward at least to Great Slave Lake. It grows on muskeg lake shores in the Wood Buffalo Park, but on rocky or sandy uplands in the pre-Cambrian country. A form with prominently spreading lateral lobes of the fruiting bracts was found in the shifting sand dunes south of William Point (no. 6889), and may prove, with more material, to be worthy of distinction. — Lake Athabaska: sand dunes about 5 mi. S. of William Pt., no. 6889. Great Slave L.: Fairchild Pt., nos. 588, 589; Ft. Reliance, no. 590.

Betula pumila L. var. **glandulifera** Regel. — Known in the Mackenzie basin from two collections, one in the Wood Buffalo Park and the other at Fort Smith. The former was growing in an upland muskeg. — Fort Smith, Slave R., *Dutilly*, no. 95 (G).

Betula glandulosa Michx. — Abundant in muskeg thickets throughout the wooded country and far into the Arctic. In the sand dunes south and southwest of William Point, Lake Athabaska, was found a form (nos. 6884, 6919) with scarcely glandular twigs and with it leaves very shiny above and strongly cuneate at the base. It grows in great clumps 8–10 feet high and serves to stabilize the shifting sand. Further material and study may justify giving it varietal distinction, but owing to the great variability of *B. glandulosa* in these characters throughout its range it is thought advisable to leave it here for the present. — Lower Athabaska R., *Kennicott* (N); Calumet, Athabaska R., no. 586. Lake Athabaska: near Sand Pt., no. 4540; mouth of Charlot R., nos. 6312, 6341; 5 mi. E. of Poplar Pt., no. 6642; along Archibald R. south of Wolverine Pt.; no. 6730; about 3 mi. E. of Wolverine Pt., no. 6815; dunes about 5 mi. S. of William Pt., no. 6884; dunes just E. of Ennuyeuse Cr., no. 6919; muskeg about 3 mi. W. of Ennuyeuse Cr., no. 6960; muskeg about 2 mi. W. of Ennuyeuse Cr., no. 6998. Great Slave L.:

R. Bell, no. 23157 (O); Taltheilei Narrows, no. 587; Maufelly Pt., no. 581; Fairchild Pt., nos. 580, 582, 583, 584, 585; Pike's Portage, *J. W. Tyrrell,* no. 23125 (O). Artillery L., *J. W. Tyrrell* (O); and *Seton & Preble,* no. 78291 (O) (*B. nana* of Seton's list).

Alnus crispa (Ait.) Pursh. — *A. alnobetula* Amer. auth. — Common to abundant throughout the wooded country, chiefly in coniferous timber. Seton and Preble give its range as northward to the limit of trees, but it was noted in Fl. Bor.-Am. as growing also in the barren country. J. W. Tyrrell collected it on the shore of Carey Lake, on the Dubawnt River, well within the barren lands. — McMurray, no. 7109. Lake Athabaska: Shelter Pt., nos. 624, 625; near Sand Pt., no. 4524; Charlot Pt., no. 6215; Cornwall Bay, no. 6600; along Archibald R., S. of Wolverine Pt., no. 6740. Along Quatre Fourches R., no. 622; upper Slave R. lowland, no. 2186. Great Slave L.: Taltheilei Narrows, no. 621; Fairchild Pt., nos. 620, 623; Yellowknife Bay, no. 626. Between Fts. Simpson and Chipewyan, *Richardson* (G) (*A. viridis* of Fl. Bor.-Am. and Macoun's Cat.).

Alnus crispa (Ait.) Pursh var. **elongata,** var. nov. PLATE 195[1]

A forma typica differt strobilis fructiferis multo elongatis (1.2–2.4 cm. longis et 0.5–0.9 cm. latis, plerisque 2 × 0.8 cm.), ellipticis vel subinde cylindricis, bracteis inferioribus distanter dispositis itaque strobilo basi attenuato.

Sandy beach on the north shore of Lake Athabaska a few miles west of Sand Point, Sept. 9, 1932, *Raup & Abbe,* no. 4665 (Type, A).

Except for its long cones, which are at once striking and distinctive, this alder is closely similar to the common *A. crispa* of the region. The type material is from a large spreading shrub, perhaps 8 feet high, growing at the upper edge of the sandy lake beach. It is of particular interest because the elongated cone affords evidence of anatomical structure not to be had in the usual forms. It has been described and figured with considerable detail by Dr. Ernst C. Abbe in his studies of inflorescence anatomy in the Betulaceae.[2]

Alnus incana (L.) Moench. — Abundant on lake shores and river banks northward in the wooded country at least to Great Slave Lake. Noted by Richardson at Fort Franklin and by Preble on Peel River. It is very doubtful if American plants of this relationship are identical with the Old World *A. incana,* but until a critical study of the problem is made the above name will serve. Western specimens are commonly

[1]PLATE 195. *Alnus crispa* (Ait.) Pursh var. *elongata* Raup. Part of type collection from the north shore of Lake Athabaska west of Sand Pt., no. 4665; detail of cone × 3.

[2]Bot. Gaz. **97**: 4–8, figs. 8–22 (1935).

called *A. tenuifolia* Nutt., but the writer has not been able to distinguish those cited below from the common eastern form usually called *incana*. — McMurray, no. 7108; Calumet, Athabaska R., nos. 609, 614. Lake Athabaska: Shelter Pt., nos. 610, 615; Sand Pt., no. 4582; Charlot Pt., nos. 6213, 6214; 5 mi. E. of Poplar Pt., no. 6681; along Archibald R., S. of Wolverine Pt., no. 6729; bank of William R. near its mouth, no. 6873. Along Quatre Fourches R., nos. 608, 612; upper Slave R. lowland, nos. 619, 2189. Great Slave L.: Fairchild Pt., nos. 613, 617; Ft. Reliance, no. 618; Yellowknife Bay, no. 616; N. W. shore, *Bedford* (O).

URTICACEAE

Urtica gracilis Ait. — See Rhod. **28:** 191 (1926). — Common in damp meadows, prairies, and cabin clearings northward in the Paleozoic and younger country to the Wood Buffalo Park, and at least occasional on the western arm of Great Slave Lake. It was noted on Great Bear Lake by Richardson. — Upper Slave R. lowland, nos. 641, 2205, 2206; N. W. shore of Great Slave L., *Bedford* (O).

SANTALACEAE

Comandra pallida A. DC. — Occasional on dry prairies and sandy hills northward to the Wood Buffalo Park, chiefly west of the Paleozoic boundary. For a discussion of parasitism in this species and the following, see a paper by E. H. Moss in the New Phytologist, **25:** 264–76 (1926). — Calumet, Athabaska R., nos. 642, 643; sandy open woods near Moose Pt., S. shore of L. Athabaska, no. 7015.

Geocaulon lividum (Richards.) Fern. — *Comandra livida* Richards. — See Rhod. **30:** 21 (1928). — Common in woodlands throughout the region. Dwarfed forms with variegated leaves are frequently found, and are treated at some length by Moss in the paper cited under the preceding species. — Calumet, Athabaska R., no. 649. Lake Athabaska: Shelter Pt., nos. 650, 652, 653, 654; Charlot Pt., no. 6083; Cornwall Bay, no. 6593; 5 mi. E. of Poplar Pt., no. 6689. Along Quatre Fourches R., no. 644; upper Slave R. lowland, no. 2196; Ft. Smith, no. 648. Great Slave L.: Taltheilei Narrows, no. 645; Fairchild Pt., nos. 646, 651; Ft. Reliance, no. 647; S. W. and N. shores, *Howe*, no. 91983 (O); N. W. shore, *Bedford* (O).

LORANTHACEAE

Arceuthobium americanum Nutt. — *Razoumofskya americana* (Nutt.) Ktze. — This species has been very little collected, and may prove to be common far northward. The following specimens, with a note of another from Lesser Slave Lake (*Brinkman*), are the only rec-

ords available for most of the Mackenzie basin. It grows on *Pinus Banksiana*. — Lake Athabaska: Shelter Pt., no. 4449; Sand Pt., no. 4472.

POLYGONACEAE

Rumex occidentalis S. Wats. — Common in wet sloughs and on river banks northward to the Wood Buffalo Park, and at least occasional on Great Slave and Great Bear Lakes (*J. M. Bell*, O). Eastward it is occasional on damp sandy lake beaches, but not far from the Paleozoic boundary. — Calumet, Athabaska R., no. 665; Shelter Pt., L. Athabaska, nos. 666, 667; upper Slave R. lowland, nos. 2214, 2216. Great Slave L.: Yellowknife Bay, no. 668; N. W. shore, *Bedford* (O).

Rumex mexicanus Meissn. — Common in damp meadows and sloughs northward to the Wood Buffalo Park, and occasional on the north shore of Lake Athabaska and the western side of Great Slave Lake. In Fl. Bor.-Am. *R. salicifolius*, which is here *R. mexicanus* at least in part, is noted on Great Bear Lake and the Mackenzie River. — McMurray, no. 7052; lower delta of Athabaska R., no. 670. Lake Athabaska: Shelter Pt., nos. 669, 671; Sand Pt., no. 4495; Charlot Pt., no. 6395. East shore of L. Mamawi, nos. 2225, 2227, 4404. Great Slave L.: N. W. shore, *Bedford* (O).

Rumex maritimus L. var. **fueginus** (Phil.) Dusén. — See Rhod. **17**: 73 (1915). — Common in damp meadows and at slough margins, mainly in the Paleozoic or younger areas northward to the Wood Buffalo Park, and at least occasional on the western arm of Great Slave Lake. — Lower delta of Athabaska R., no. 673; Shelter Pt., L. Athabaska, no. 672; upper Slave R. lowland, nos. 2220, 2221, 2222; N. W. shore of Great Slave L., *Bedford* (O).

Polygonum prolificum (Small) B. L. Robinson. — Known in the Mackenzie basin from a single locality in the Salt Plain region of the Wood Buffalo Park.

Polygonum aviculare L. — Common in damp sloughs, rock crevices and cabin clearings throughout the lowlands northward to Great Slave Lake, and occasional in the upland districts west of the Slave River. Noted in Fl. Bor.-Am. north to Lat. 65°. — Reed's Portage, upper delta of Athabaska R., no. 2234; E. shore of L. Mamawi, no. 2233; upper Slave R. lowland, no. 2232; Ft. Smith, no. 658; N. W. shore of Great Slave L., *Bedford* (O).

Polygonum Douglasii Greene. — Known in our region only at the western end of L. Athabaska, where it grows in small patches of soil among the granite hills. — Fort Chipewyan, nos. 4696, 7043.

Polygonum viviparum L. — *Bistorta vivipara* (L.) S. F. Gray. —

Common in muskegs and on damp sandy lake shores in the more arctic parts of the region. Southward it is only occasional. — Calumet, Athabaska R., no. 657. Great Slave L.: Fairchild Pt., nos. 655, 656; Windy Pt., *Hume,* no. 102660(O).

Polygonum lapathifolium L. var. **salicifolium** Sibth. — *P. tomentosum* Schrank var. *incanum* (Schmidt) Gürke. — See Rhod. **23:** 259 (1921). Occasional on damp slough margins northward at least to the Wood Buffalo Park, mainly west of the Paleozoic boundary. In the pre-Cambrian it has been found only on damp sandy shores near the western end of Lake Athabaska. A note in Fl. Bor.-Am. under *P. Persicaria* var. *minus,* "Saskatchewan to Great Bear Lake. Dr. Richardson," probably refers to this species. — Shelter Pt., L. Athabaska, nos. 659, 660, 661; E. shore of L. Mamawi, no. 2254.

Polygonum natans A. Eat. and forma **Hartwrightii** (Gray) Stanford. — See Rhod. **27:** 156–62 (1925). — Common on lake and slough margins, and in sluggish streams northward to Great Slave Lake. It has not been observed about the eastern arm of Great Slave Lake, but Harper reported a *Polygonum amphibium* at the junction of the Tazin and Taltson Rivers which may have been this species. The creeping mud plant with hairy leaves and stem, sometimes known as *P. Hartwrightii,* is clearly no more than a form of the aquatic one. — Delta of Athabaska R., no. 2248. Lake Athabaska: Shelter Pt., nos. 662, 664; near mouth of Charlot R., no. 6348; pond near base of Cornwall Bay, no. 6613; 2 mi. W. of Ennuyeuse Cr., nos. 6987, 6989. East shore of L. Mamawi, nos. 2249, 2250, 4407; upper Slave R. lowland, nos. 2241, 2242, 2246, 2251; Ft. Smith, no. 663; N. W. shore of Great Slave L., *Bedford* (O).

POLYGONUM CONVOLVULUS L. — *Bilderdykia Convolvulus* (L.) Dum. — Occasional in dry cleared ground along the main routes of travel in the Wood Buffalo Park, and probably southward. — East shore of L. Mamawi, nos. 2237, 2239; upper Slave R. lowland, no. 2236.

CHENOPODIACEAE

Chenopodium capitatum (L.) Asch. — *Blitum capitatum* L. — Rather common in the northern and northeastern part of the area, usually in disturbed soil, as in settlements and cabin clearings. — Upper Slave R. lowland, no. 2266; Ft. Smith (*Mrs. Conibear,* coll.) no. 676; lower Slave R., no. 675. Great Slave L.: N. shore of McLeod Bay, no. 677; Fairchild Pt., no. 674; N. W. shore, *Bedford* (O).

Chenopodium glaucum L. — The only authentic record in the Mackenzie basin is cited below. It has been reported on the Peace River and at Lesser Slave Lake, and there is a note in the botanical

appendix to Back's Narrative, "Athabasca," the significance of which is unknown. — Damp soil on bank of Athabaska R., McMurray, no. 7063.

Chenopodium rubrum L. — Known in the Mackenzie basin from a single locality in the Wood Buffalo Park, on the Salt Plains west of the upper Slave River.

Chenopodium album L. — Abundant as a weed in settlements and cabin clearings, and occasional in burned-over country or in meadows, northward at least to the Wood Buffalo Park. On Lake Athabaska it usually grows on damp shores. Noted on the Slave River and at the mouth of the Taltson by Harper, and from "Lake Huron . . . to Bear Lake" by Richardson. — McMurray, nos. 7060, 7079. Lake Athabaska: Shelter Pt., no. 678; cabin clearing about 3 mi. W. of Ennuyeuse Cr., no. 6958. East shore of L. Mamawi, nos. 2269, 2270; upper Slave R. lowland, nos. 2275, 2276.

Chenopodium lanceolatum Muhl. — *C. album* L. var. *viride* (L.) Moq. — Known in the Mackenzie basin only from collections in dry upland prairies in the Wood Buffalo Park.

Chenopodium leptophyllum Nutt. — Apparently rare or occasional in our region, and confined to dry semi-open prairies. Known also at Ft. Franklin (*Richardson*, G). — Small prairie on granite hill, E. shore of L. Mamawi, no. 2278.

Atriplex patula L. — This and its variety are known in the Mackenzie basin only from the Wood Buffalo Park where they grow in semi-saline situations, and together make an extremely variable group of plants which needs further study. An unverified record in the botanical appendix to Back's Narrative for *A. litoralis*, "Athabasca," may refer to this species. — Upper Slave R. lowland (Gov. Hay Camp), no. 2258.

Atriplex patula L. var. **hastata** (L.) Gray. — Common on the Salt Plain in the Wood Buffalo Park.

AXYRIS AMARANTHOIDES L. — An introduced weed known only from a single collection. — McMurray, no. 7117.

Corispermum hyssopifolium L. — The only authentic Mackenzie basin record is cited below. Noted by Macoun on the Peace River. — Great Slave L.; *Richardson* (G).

Salicornia europaea L. — Abundant at the margins of saline flats and brine springs west of the Slave River, and reported in the southwestern part of the Mackenzie basin.

Suaeda depressa (Pursh) S. Wats. — *Dondia depressa* (Pursh) Britton. — At least occasional at the margins of saline flats in the Wood Buffalo Park, and noted in the southwestern part of the Mackenzie basin by Macoun.

CARYOPHYLLACEAE

Stellaria borealis Bigelow. — *Alsine borealis* (Bigelow) Britton. — See Rhod. **16**: 144–51 (1914). — Common in wet meadows, sloughs, or in muskegs, and on damp shores. Known northward to the Mackenzie and Great Bear Lake (*Onion,* N; *J. M. Bell,* O). — Lake Athabaska: Shelter Pt., nos. 724, 4455; Sand Pt., no. 4492; Cornwall Bay, no. 6490. Upper Slave R. lowland, nos. 2315, 2316; Ft. Smith, no. 728. Great Slave L.: Keith Isl., no. 725; Taltheilei Narrows, nos. 726, 727; N. W. shore, 12 mi. E. of Moraine Pt., *Bedford* (O).

Stellaria crassifolia Ehrh. — *Alsine crassifolia* (Ehrh.) Britton. — Occasional in muskeg sloughs northward at least to the Wood Buffalo Park. A record in Fl. Bor.-Am. under *S. gracilis,* "About Slave Lake," is probably referable to this, and also one in Macoun's Cat., "Methye River, near Portage la Loche."

Stellaria longipes Goldie. — *Alsine longipes* (Goldie) Cov. — Common or abundant throughout the region, and northward to the lower Mackenzie and Great Bear Lake (*Miss E. Taylor,* O; *J. M. Bell,* O). It grows in a variety of habitats, from dry prairies and beaches to sloughs and muskegs. A glaucous form with erect leaves is commonly called var. *laeta* (Richards.) Wats., but the many intergrading forms which fail to show any regional segregation in this country, have led the writer to merge the two. — Calumet, Athabaska R., no. 712. Lake Athabaska: Chipewyan, nos. 6060, 7032; Shelter Pt., nos. 706, 707; Sand Pt., nos. 4497, 4543; Charlot Pt., nos. 6102, 6103, 6303; shore of main lake just W. of Ellis Bay, no. 6268; mouth of Charlot R., no. 6333; Cornwall Bay, no. 6555; 2 mi. E. of Wolverine Pt., no. 6720. East shore of L. Mamawi, nos. 2336, 2337; Ft. Smith, no. 717; and *Dutilly,* no. 94(G); and *Seton & Preble,* no. 78318(O); and *Miss E. Taylor* (G, O). Great Slave L.: Resolution, *Kennicott* (N); Taltheilei Narrows, no. 709; Fairchild Pt., nos. 708, 711, 716; Ft. Reliance, nos. 713, 714, 715; Hay R., *Hume,* no. 102661(O); S. W. and N. shores, *Howe,* no. 91981(O); Yellowknife R., *Russell* (O).

Stellaria arenicola, sp. nov. PLATE 196[1]

Herba perennis glabra, subviridis et lucida, caulibus satis gracilibus laxis quadrangularibus ex radice repente ascendentibus et supra ramosis; caules 1–4 dm. longi; folia lanceolata, 0.8–2.8 cm. longa, ad 4 mm. lata, supra basin latissima, 1-nervia, pleraque ascendentia, argute acuta, inferiora minora; cymae terminales, patulae, 1–5-ramosae, pedicellis

[1]PLATE 196. *Stellaria arenicola* Raup. Part of type collection from sand dunes south of William Pt., L. Athabaska, no. 6882; details of capsules × 2 (capsules on the right are from no. 6910). Habit photo. taken on same dune area, just E. of Ennuyeuse Cr., Aug. 20, 1935.

gracilibus 0.3–2.5 cm. longis; bracteae scariosae, lanceolatae, 2–4 mm. longae; sepala ovata, obtusa vel late acuta, medio 3-nervia et viridia, marginibus latis scariosis, 3–3.5 mm. longa, 1.5–2 mm. lata; petala circa 5 mm. longa, alba, aliquando fere ad basin divisa; capsula straminea, anguste ovoidea, circa 6 mm. longa, apicibus valvularum recurvatis et post dehiscentiam revolutis; styli 3; semina circa 1 mm. longa, minute asperata.

Among inland shifting sand dunes south of William Point, south shore of Lake Athabaska, Sask., Aug. 16, 1935, no. 6882 (Type, G). Two other numbers were collected from the same dune area: no. 6883 is from the same locality as the type, while no. 6910 was obtained about four miles to the westward on Aug. 20, 1935. Both nos. 6883 and 6910 have older capsules than no. 6882.

In habit and general appearance this plant most nearly resembles *S. graminea* L. and *S. longipes*. It differs sharply from *S. graminea* in having ovate, obtuse or broadly acute sepals with broad scarious margins which entirely surround the apex, and in having the valves of its capsules recurved and rolled back after dehiscence. Furthermore the seeds, although clearly roughened, are not deeply sculptured as in *S. graminea*. Also its leaves are not ciliate at the base as in the latter species. From *S. longipes* it differs in having straw-colored capsules with reflexed and rolled valves in the mature condition. It grows in the actively shifting sands and serves as a fixing agent for small dunes.

Stellaria longifolia Muhl. — *Alsine longifolia* (Muhl.) Britton. — Abundant in wet meadows, damp prairies and muskegs northward at least to the Wood Buffalo Park, and known on the Mackenzie (*Kennicott*, N). Apparently rare in the pre-Cambrian. — Lake Athabaska: mouth of Charlot R., no. 6360; Cornwall Bay, no. 6490-a. East shore of L. Mamawi, no. 2303; Peace delta and upper Slave R. lowland, nos. 720, 721, 722, 2309; Ft. Smith, nos. 718, 723; Yellowknife Bay, Great Slave L., no. 719.

Stellaria media (L.) Cyrill. — *Alsine media* L. — Known in our region from a single collection on Lake Athabaska, and not thus far found to the northward. — Damp thicket at Chipewyan, no. 4673.

Cerastium alpinum L. var. **glanduliferum** Koch. — See Rhod. **22**: 169–79 (1920). — Known in the Mackenzie basin only from the following. It grows in rock crevices and on gravelly shores. — Great Slave L.: Taltheilei Narrows, no. 698; Fairchild Pt., nos. 696, 697.

Cerastium Beeringianum Cham. & Schl. — See Rhod. **22**: 169–79 1920). — Common on damp shores and in rock crevices on the north side of Lake Athabaska, but apparently rare elsewhere in the region. —

Lake Athabaska: near Sand Pt., no. 4493; W. shore of Ellis Bay, no. 6163; Charlot Pt., nos. 6230, 6384; mouth of Charlot R., no. 6338; Fishhook Bay, no. 6587. Near Ft. Smith, no. 694.

Cerastium nutans Raf. — Occasional on damp sandy lake and slough margins and in damp rock crevices northward to the Wood Buffalo Park, but scarcely known eastward of the Paleozoic boundary. — Chipewyan, no. 4702; E. shore of L. Mamawi, no. 2296.

Cerastium arvense L. — See Rhod. **22:** 178–9 (1920). — Common in rather dry prairie openings and rock crevices in the Wood Buffalo Park and southwestward, but scarcely known east of the Paleozoic boundary. — Chipewyan, no. 6072; and near Chipewyan, Athabaska R., *Harper,* no. 91209(O).

Sagina nodosa (L.) Fenzl. — Common in damp rock crevices and on damp sandy shores in the pre-Cambrian country. Noted in Fl. Bor.-Am., under *Spergula nodosa,* "Ontario, to the shores of the Arctic Sea, eastward of the Mackenzie River." — Lake Athabaska: Shelter Pt., nos. 700, 701, 702, 4428; Sand Pt., nos. 4484, 4542; W. shore of Ellis Bay, no. 6370; small island near base of Charlot Pt., no. 6379. Great Slave L.: Fairchild Pt., nos. 703, 704; Ft. Reliance, no. 704.

Arenaria verna L. var. **pubescens** (Cham. & Schl.) Fern. — See Rhod. **21:** 21–2 (1919). — An arctic species common or occasional in rock crevices, mainly in the pre-Cambrian areas. — Clearwater R., lat. 56°, *J. M. Macoun,* no. 4868(O). Lake Athabaska: Chipewyan, nos. 4682, 7029; Charlot Pt., nos. 6104, 6258; Cornwall Bay, no. 6564. Great Slave L.: nos. 691, 692.

Arenaria humifusa Wahlenb. — *A. cylindrocarpa* Fern. — See Nordhagen, Bergens Mus. Årbok 1935, Naturvidenskap. rek. no. 1 (1935). — Apparently rare in the Mackenzie basin, and known from a single collection on Great Slave Lake. It was growing on a stony-sandy shore. — Fairchild Pt., no. 693.

Arenaria dawsonensis Britton. — *A. litorea* Fern. — See Mem. Amer. Acad. **15:** 276 (1925). — Occasional to common in the pre-Cambrian regions, growing in damp rock crevices and on lake shores. It is occasional in meadows and muskegs in the Wood Buffalo Park. Records for *A. stricta* in Fl. Bor.-Am., and for *A. Michauxii* in Macoun's Cat., ". . . to the shores of the Arctic Sea," may refer to this species. — Lake Athabaska: Shelter Pt., no. 690; Charlot Pt., nos. 6136, 6309; Cornwall Bay, no. 6453; limestone hill N. E. of Cornwall Bay, nos. 6526, 6541-a. Great Slave L.: Keith Isl., no. 689; Maufelly Pt., no. 686; Fairchild Pt., nos. 687, 688.

Arenaria lateriflora L. — *Moehringia lateriflora* (L.) Fenzl. —

See Rhod. **19:** 259 (1917). — Common to abundant in shady woods throughout the Paleozoic and younger country northward to the lower Mackenzie (*Dutilly,* G; *Miss E. Taylor,* O, G), but scarcely known in the pre-Cambrian. — Waterways, no. 2282; Calumet, Athabaska R., no. 682; E. shore of L. Mamawi, no. 2286; upper Slave R. lowland, nos. 684, 685; Ft. Smith, no. 683. Great Slave L.: Resolution, *Miss E. Taylor,* no. 51(O); N. W. shore, *Bedford* (O); near Ft. Rae, *Russell* (O).

Arenaria macrophylla Hook. — Apparently common in rich woods on rocky hills and old lake beaches in the pre-Cambrian areas, but not known elsewhere in the Mackenzie basin. — Lake Athabaska: W. shore of Ellis Bay, no. 6165; Charlot Pt., nos. 6280, 6388; near Cornwall Bay, S. of Wabba L., no. 6482. Great Slave L.: Taltheilei Narrows, no. 679; Fairchild Pt., no. 680; Ft. Reliance, no. 681.

Spergularia salina J. & C. Presl. — *S. marina* Griseb. of Gray's Man., 7th ed. — *Tissa salina* (Presl) Greene. — See Rhod. **12:** 157 (1910). — Common at the margins of saline flats in the Wood Buffalo Park. A note in Fl. Bor.-Am. under *Arenaria rubra,* and repeated in Macoun's Cat. under *Spergularia media,* "between Cumberland House and Bear Lake," may refer to this species.

Silene acaulis L. var. **exscapa** (All.) DC. — See Rhod. **23:** 119–20 (1921). — An arctic species known in our region only on exposed rock crevices about the eastern arm of Great Slave Lake. — Taltheilei Narrows, no. 699; Pike's Portage, *J. W. Tyrrell,* no. 100703(O).

Silene antirrhina L. — Known in the Mackenzie basin east of the mountains only on the north shore of Lake Athabaska where it grows on turfy hillsides. — Chipewyan, no. 7045; Cornwall Bay, nos. 6451, 6563.

Lychnis Drummondii (Hook.) Wats. — *Wahlbergella Drummondii* (Hook.) Rydb. — Occasional in dry prairies in the Wood Buffalo Park, and known elsewhere in our region only on dry calcareous slopes on the north shore of Lake Athabaska. — Charlot Pt., nos. 6090, 6405; Cornwall Bay, nos. 6445, 6561.

NYMPHAEACEAE

Nymphozanthus variegatus (Engelm.) Fern. — *Nymphaea variegata* (Engelm.) G. S. Miller. — See Rhod. **21:** 187 (1919). — Common to abundant in shallow lakes, ponds, and sluggish streams throughout our region. Richardson's record in Fl. Bor.-Am., under *Nuphar lutea,* "Wooded country Lat. 54°–64°" probably refers to this species and it is known at Great Bear Lake (*J. M. Bell,* O). — Mamawi Cr., Athabaska delta, no. 2350. Lake Athabaska: Shelter Pt., no. 639; pond just

N. of Cornwall Bay, no. 6614; about 2 mi. W. of Ennuyeuse Cr., no. 7000. Upper Slave R. lowland, no. 2347. Great Slave L.: Fairchild Pt., nos. 637, 638; Belle Isl., Charlton Bay, no. 640; N. W. shore, *Bedford* (O).

CERATOPHYLLACEAE

Ceratophyllum demersum L. — Known in the Mackenzie basin from a single collection in the Wood Buffalo Park. — Slough pond along Murdock Cr., no. 2345.

RANUNCULACEAE

Coptis groenlandica (Oeder) Fern. — See Rhod. **31**: 136–42 (1929). — The only Mackenzie basin collections are from Lesser Slave Lake (*Brinkman*, N) and the following. — Thickets on margin of sandy muskeg pond about 5 mi. S. E. of Wolverine Pt., L. Athabaska, no. 6824.

Actaea rubra (Ait.) Willd. — Common in open woods and thickets northward in the Paleozoic and younger country to the Wood Buffalo Park, and known on the Mackenzie (*Onion, Kennicott & Hardisty*, N). Apparently occasional in the pre-Cambrian. — Waterways, no. 2402; Calumet, Athabaska R., no. 756; along lower Firebag R., no. 6036. Lake Athabaska: hills south of Wabba L., no. 6485; Cornwall Bay, no. 6502. East shore of L. Mamawi, no. 2390; upper Slave R. lowland, nos. 755, 2394, 2398, 2399; Ft. Smith district, nos. 754, 757.

Aquilegia brevistyla Hook. — Occasional in rather open woods northward to the lower Mackenzie (*Miss E. Taylor*, O) and Great Bear Lake (*Richardson*, O). In the botanical appendix to Back's Narrative is a record for *A. canadensis* var. *hybrida* at "Slave Lake," which probably refers to this species. — Clearwater R., *J. M. Macoun*, no. 1301 (O); McMurray, *J. M. Macoun*, no. 1302(O); Calumet, Athabaska R., no. 758. Lake Athabaska: Sand Pt., no. 4642; Charlot Pt., nos. 6239, 6276; W. shore of Ellis Bay, no. 6369; Cornwall Bay, no. 6465. Fort Smith, no. 760. Great Slave L.: base of Maufelly Pt., no. 759; Fairchild Pt., no. 761; Windy Pt., *Hume*, no. 102662(O); Old Ft. Rae, *Russell* (O).

Delphinium scopulorum Gray var. **glaucum** Gray. — Common or occasional in open woods, northward to the Wood Buffalo Park and known on the Mackenzie (*Onion*, N); but apparently confined to the Paleozoic or younger lands. It is sometimes abundant in prairies. — McMurray, no. 7118; upper Slave R. lowland, nos. 2355, 2356; lower Slave R., *Russell*, no. 75(G); Resolution, *Kennicott* (N).

Anemone parviflora Michx. — Occasional or common in the north-

ern and northeastern parts of our region, where it usually grows in muskegs. Also known on the Mackenzie (*McConnell,* O; *Onion,* N) and at Great Bear Lake (*J. M. Bell,* O). — North shore of L. Athabaska, *J. W. Tyrrell,* no. 100760, in part (O); Ft. Smith, *Miss E. Taylor,* no. 955(O). Great Slave L.: Maufelly Pt., no. 772; Fairchild Pt., no. 771; Pine Pt., *Brooke* (O). Near lower end of Artillery L., *J. W. Tyrrell,* no. 23149(O).

Anemone multifida Poir. var. **hudsoniana** DC. — See Rhod. **19:** 141 (1917). — Common on dry ridges and prairies, and in rock crevices northward to Great Bear Lake (*J. M. Bell,* O) and the Mackenzie (*Dutilly,* G; *Onion, Kennicott & Hardisty,* N; *Miss E. Taylor,* O). Most of the material cited below is forma *sanguinea* (Pursh) Fern. — Calumet, Athabaska R., no. 775. Lake Athabaska: Charlot Pt., no. 6233; Cornwall Bay, no. 6441. Upper Slave R. lowland, no. 2417; Ft. Smith, no. 774, and *Miss E. Taylor,* no. 48(O), and *Seton & Preble,* no. 78313 (O). Great Slave L.: Resolution, *Kennicott* (N); Maufelly Pt., no. 773; Fairchild Pt., nos. 776, 777; Windy Pt., *Hume,* no. 102663(O); Old Ft. Rae, *Russell* (O).

Anemone cylindrica Gray. — At least occasional in the more southern districts where it grows in dry woods and prairies, and known also at Peace Point. — McMurray, no. 7050.

Anemone Richardsonii Hook. — An arctic and alpine species known in our region only on the north shore of Lake Athabaska. — Lake Athabaska: N. shore, *J. W. Tyrrell,* no. 100760, in part (O); Camsell Portage, no. 6203.

Anemone canadensis L. — Common in the Wood Buffalo Park and southward, growing at slough margins and in prairies, but not known eastward of the Paleozoic boundary. Noted in Fl. Bor.-Am., under *A. pennsylvanica,* "from the United States to near the Mouth of Mackenzie River; not found in the barren grounds"; and in the botanical appendix to Back's Narrative it is reported on "Slave Lake." The writer has seen no material from north of the Wood Buffalo Park. — McMurray, *Dutilly,* no. 121(G); Calumet, Athabaska R., no. 770; E. shore of L. Mamawi, nos. 2424, 2426, 4398; upper Slave R. lowland, no. 769.

Pulsatilla ludoviciana (Nutt.) Heller. — *Anemone patens* L. var. *Wolfgangiana* (Bess.) Koch. — Common on dry sandy or rocky ridges and in dry prairies, northward to Great Bear Lake (*J. M. Bell,* O) and the lower Mackenzie (*McConnell,* O; *H. W. Jones,* O; *Kennicott,* N). — Lake Athabaska: Chipewyan, no. 6073; and *J. W. Tyrrell,* no. 100765(O) (*A. patens* var. *Nuttalliana* of Tyrrell's list); Shelter Pt., no. 768; Sand Pt., no. 4669; Charlot Pt., nos. 6089, 6138; Cornwall

Bay, no. 6571. Along Quatre Fourches R., no. 765; Ft. Smith, nos. 766, 2403; and *Seton & Preble*, no. 78314(O). Great Slave L.: base of Maufelly Pt., no. 767; Ft. Reliance, no. 764.

Ranunculus trichophyllus Chaix var. **typicus** Drew. — *R. aquatilis* L. var. *capillaceus* DC., at least in part. — See Rhod. **38**: 17–39 (1936). — Common in shallow lakes, ponds, and slow streams, northward at least to Great Slave Lake. Although it is known in the pre-Cambrian about Great Slave Lake it has not been found in similar country on Lake Athabaska. Noted in Fl. Bor.-Am. "to near the Arctic Sea, lat. 68°." — Mamawi Cr., no. 2370; upper Slave R. lowland, no. 729. Great Slave L.: Fairchild Pt., nos. 730, 731, 732; N. W. shore, *Bedford* (O).

Ranunculus Purshii Richards. — Common in slough ponds throughout our region, and known northward to the Mackenzie River (*Onion, Kennicott & Hardisty,* N). Noted at Great Bear Lake in Fl. Bor.-Am. — Calumet, Athabaska R., no. 735. Lake Athabaska: Shelter Pt., nos. 736, 737; Cornwall Bay, nos. 6491, 6626. Upper Slave R. lowland, nos. 734, 2377, 2378, 2379; Smith Portage, Slave R., *Miss E. Taylor,* no. 1109(O). Great Slave L.: Resolution, *Miss E. Taylor,* no. 22(G); N. W. shore, *Bedford* (O).

Ranunculus hyperboreus Rottb. — Known in the Mackenzie basin from a single collection in the Wood Buffalo Park.

Ranunculus reptans L. — Common or occasional on damp sandy or stony lake shores, chiefly in the pre-Cambrian country. Noted in Fl. Bor.-Am., under *R. Flammula* vars., "On gravelly banks of rivers to lat. 69°." — Lake Athabaska: Shelter Pt., nos. 752, 4442; along Charlot R. near its mouth, no. 6362; 5 mi. S. E. of Wolverine Pt., no. 6820; 2 mi. W. of Ennuyeuse Cr., no. 6982. Great Slave L.: Fairchild Pt., nos. 749, 750, 751; N. W. shore, *Bedford* (O).

Ranunculus lapponicus L. — Occasional in muskegs throughout our region and into the Arctic. — Clearwater R., *J. M. Macoun,* no. 1099(O). Lake Athabaska: Shelter Pt., no. 740; N. of Charlot R., no. 6359; hills N. E. of Cornwall Bay, no. 6539; 5 mi. E. of Poplar Pt., nos. 6667, 6701. Great Slave L.: Taltheilei Narrows, no. 738; Fairchild Pt., no. 739. East end of Clinton-Colden L., *J. W. Tyrrell,* no. 23148 (O) (*R. hyperboreus* of Tyrrell's list).

Ranunculus pedatifidus J. E. Sm. — This species is represented in our region mainly by its var. *cardiophyllus,* but the typical form has been found on a rocky hill at the western end of Lake Athabaska. — Chipewyan, no. 6051.

Ranunculus pedatifidus J. E. Sm. var. **cardiophyllus** (Hook.)

Britton. — *R. cardiophyllus* Hook. — See Rhod. **36**: 93–6 (1934). — Apparently rare in our region generally, but quite common in small patches of soil on granite hills at the western end of Lake Athabaska. Records in Fl. Bor.-Am. and in the botanical appendix to Back's Narrative under *R. affinis* probably refer to *R. pedatifidus* or some form of it. In the former it is noted as "Universally spread from Canada to the Arctic Sea," and in the latter for "Slave Lake." A note in Back's Narrative under *R. auricomus,* "Thlew-ee-choh and Athabasca," probably also belongs here. — Chipewyan, nos. 4679, 6056, 7037.

Ranunculus rhomboideus Goldie. — A plains species known in our region only on prairies in the Wood Buffalo Park.

Ranunculus abortivus L. — Occasional in muskegs and lowland woods northward at least to the Wood Buffalo Park, but not found thus far east of the Paleozoic boundary.

Ranunculus sceleratus L. — Common on wet pond and lake shores northward in the Paleozoic or younger country at least to the Wood Buffalo Park. Noted by Richardson northward to "Slave Lake and north to Lat. 67°"; and noted on Great Slave Lake both in Back's Narrative and later in Harper's list. — Lower delta of Athabaska R., no. 746; Chipewyan, no. 7033; upper Slave R. lowlands, nos. 745, 2385, 2386; N. W. shore of Great Slave L., *Bedford* (O).

Ranunculus tenellus Nutt. — Known in the Mackenzie basin from a single collection in a flood plain slough along the lower Peace River near the western boundary of the Wood Buffalo Park.

Ranunculus pennsylvanicus Michx. — Apparently occasional northward to the Wood Buffalo Park, growing on wet river banks or on damp lake shores. Scarcely extending east of the Paleozoic boundary. In Fl. Bor.-Am. it is noted as occurring with *R. hispidus* (*R. Macounii*) and "equally diffused," but more recent collections of the two species do not bear this out. — Calumet, Athabaska R., no. 742; lower delta of Athabaska R., no. 744; Shelter Pt., L. Athabaska, no. 743; E. shore of L. Mamawi, no. 2360.

Ranunculus Macounii Britton. — Rather common in damp sloughs northward in the non-crystalline regions at least to the Wood Buffalo Park. Noted in Fl. Bor.-Am., under *R. hispidus,* "Banks of rivers from Canada to near the mouth of the Mackenzie River, lat. 67°," but the writer has seen no material from beyond Fort Simpson (*Onion, Kennicott & Hardisty,* N). — Upper Slave R. lowland, nos. 2363, 2365; Fort Smith, no. 741; N. W. shore of Great Slave L., *Bedford* (O).

RANUNCULUS ACRIS L. — An introduced weed known in our region only about settlements. — Smith Portage Rd., no. 747; Ft. Smith, *Russell,* no. 30(G).

Ranunculus Cymbalaria Pursh. — *Halerpestes Cymbalaria* (Pursh) Greene. — See Rhod. **16:** 160 (1914). — Noted in Fl. Bor.-Am., "from Canada to near the Arctic Sea, lat. 68°," but the writer has seen no material from north of the Wood Buffalo Park where it is common on muddy slough and stream margins, particularly those of slightly saline nature. — Upper Slave R. lowlands, no. 2366; Ft. Smith, no. 733.

Thalictrum sparsiflorum Turcz. — Apparently quite rare in the Mackenzie basin and known east of the Rocky Mountains only from the Lesser Slave Lake district (*Brinkman,* N), and in the western uplands of the Wood Buffalo Park. The record in Fl. Bor.-Am. "Found only on Portage La Loche, . . ." is probably referable to this species though the writer has not seen the Richardson material.

Thalictrum venulosum Trel. — Common in prairie openings and open woods northward in the Paleozoic or younger regions at least to the Wood Buffalo Park. The record in Fl. Bor.-Am., "from Canada to the banks of the Mackenzie River, in lat. 67°," under *T. dioicum,* probably refers to this species at least with regard to our region. — Waterways, no. 2435; McMurray, no. 7073; along lower Firebag R., no. 6014?; N. shore of Great Slave L., *Hume,* no. 102664(O).

Caltha palustris L. — Apparently occasional in the timbered lowlands northward to Great Slave Lake, and known on the lower Mackenzie as forma *radicans* (*Miss E. Taylor,* O). — Calumet, Athabaska R., no. 763. Great Slave L.: near Pine Pt., *Brooke* (O); near Big Island, *Onion, Kennicott & Hardisty* (N).

PAPAVERACEAE

Corydalis sempervirens (L.) Pers. — *Capnoides sempervirens* (L.) Borkh. — Occasional in rocky places northward to the Mackenzie (*Miss E. Taylor,* O); most frequent in the pre-Cambrian country. — L. Athabaska: Shelter Pt., nos. 785, 786; Sand Pt., nos. 4473, 4531, 4595; Charlot Pt., no. 6088; N. shore of Ellis Bay, no. 6115; N. shore, *J. W. Tyrrell,* no. 2315(O) (*C. glauca* of Tyrrell's list). Along the Quatre Fourches R., no. 783; upper Slave R. lowlands, no. 2443. Great Slave L.: Taltheilei Narrows, no. 784; Yellowknife R., *Russell* (O); S. W. and N. shores, *Howe,* no. 91980(O); N. W. shore, *Bedford* (O).

Corydalis aurea Willd. — *Capnoides aurea* (Willd.) Ktze. — Common in cabin clearings, disturbed soil, and newly burned areas northward to the Mackenzie (*Dutilly,* G; *Onion, Kennicott & Hardisty,* N), and Great Bear Lake (*J. M. Bell,* O). — Along lower Firebag R., no. 6033. L. Athabaska: Chipewyan, no. 6052; Shelter Pt., no. 782; N. shore, *J. W. Tyrrell,* no. 1554(O). Upper Slave R. lowland, no. 2441; Ft. Smith, *Seton & Preble,* no. 78315(O) (apparently *C. lutea* of Seton's

list, in part); lower Slave R., no. 781; Resolution, *Kennicott* (N).

CRUCIFERAE

Draba aurea M. Vahl. — See Rhod. **36:** 299–302 (1934). — Known in our region only on turfy slopes and in rock crevices on the north shore of Lake Athabaska. — Charlot Pt., nos. 6128, 6133, 6274.

Draba glabella Pursh. — *D. hirta* of auth. — See Rhod. **36:** 333 (1934). — Known only from two collections in our region, both on Great Slave Lake. — Taltheilei Narrows, no. 810; Yellowknife R., *Russell* (O).

Draba lanceolata Royle. — *D. stylaris* of auth. — See Rhod. **36:** 357 (1934). — Occasional in rock crevices and on turfy slopes in the pre-Cambrian areas. — L. Athabaska: Charlot Pt., no. 6252; Cornwall Bay, nos. 6457, 6535, 6608. Great Slave L.: Fairchild Pt., nos. 811, 812.

Draba cinerea Adams. — See Svensk Botanisk Tidskrift, **24:** 483–6 (1929) and Rhod. **36:** 359–60 (1934). — Occasional on dry ridges and ancient beaches in the pre-Cambrian country, and known only from calcareous areas. — L. Athabaska: hills near base of Cornwall Bay, nos. 6536, 6572. Great Slave L.: Fairchild Pt., no. 809.

Draba nemorosa L. — See Rhod. **36:** 365 (1934). — Common in dry prairies, clearings, and on sandy lake shores northward at least to the Wood Buffalo Park, mainly in the non-crystalline country. A common weed about settlements. Noted in Fl. Bor.-Am., under *D. lutea,* "from lat. 56° to 66°." — Waterways, no. 2448; Fond du Lac, L. Athabaska, *J. W. Tyrrell,* no. 2011(O) (var. *leiocarpa* of Tyrrell's list); Ft. Smith, no. 808; and *Seton & Preble,* no. 78316(O); Resolution, *Kennicott* (N).

THLASPI ARVENSE L. — Occasional as an adventive weed in settled areas. — Waterways, no. 2455; Gov. Hay Camp, Slave R., no. 2454.

Lepidium apetalum Willd. — Occasional in dry prairie openings and disturbed ground northward to the Mackenzie (*Kennicott,* N). Noted in Fl. Bor.-Am., under *L. ruderale,* "from lat. 50° to 68°." Most American material of this affinity has been called *L. densiflorum* Schrad., but our material matches very well with a fragment of Willdenow's type in the Gray Herbarium. — Chipewyan, L. Athabaska, no. 7038.

CAPSELLA BURSA-PASTORIS (L.) Medic. — *Bursa Bursa-pastoris* (L.) Britton. — Adventive and very common about settlements. Noted in Fl. Bor.-Am. as far north as Great Bear Lake. — Waterways, no. 2461. L. Athabaska: Camsell Portage, no. 6172; about 3 mi. W. of Ennuyeuse Cr. (cabin clearing), no. 6955. Upper Slave R. lowland, no. 2462; Ft. Smith, no. 797.

CAMELLINA SATIVA (L.) Crantz. — Adventive in cabin clearings and settled areas in the Wood Buffalo Park. — Gov. Hay Camp, Slave R., no. 2459.

NESLIA PANICULATA (L.) Desv. — Adventive in cabin clearings and settled districts in the Wood Buffalo Park. — Gov. Hay Camp, Slave R., nos. 2457, 2458.

BRASSICA ARVENSIS (L.) Ktze. — Adventive in settled districts. — Gov. Hay Camp, Slave R., no. 2456.

Sisymbrium salsuginosum Pall. — See Univ. Wyo. Pub. in Bot. **1**: 1–27 (1922). — A far northwestern species apparently common or occasional in the Salt Plains west of the upper Slave River, but unknown elsewhere in the Mackenzie basin.

Descurainia sophioides (Fisch.) O. E. Schulz. — An arctic species known in our region only on the northwest shore of Great Slave Lake. — 12 mi. E. of Moraine Pt., *Bedford* (O).

Descurainia Richardsonii (Sweet) O. E. Schultz. — Apparently occasional in clearings and prairies northward to the Mackenzie, chiefly west of the Paleozoic boundary. Part of the Mackenzie basin plants cited in Fl. Bor.-Am., under *Sisymbrium canescens* and *S. brachycarpum*, and possibly also part of those under *S. sophioides*, probably belong here, though the writer has seen none of them. — North shore of McLeod Bay, Great Slave L., no. 813.

Braya humilis (C. A. Mey.) B. L. Robinson. — See Syn. Fl. N. Am. **1**: 141 (1895). — An arctic species apparently quite rare in our region, and known only on the northwest shore of Great Slave Lake. There is a record in Tyrrell's list of 1893 for *S. humile* at Chipewyan, but the writer has not been able to find the specimen upon which it was based. — Northwest shore of Great Slave L., *Bedford* (O).

Erysimum cheiranthoides L. — *Cheirinia cheiranthoides* (L.) Link. — Common to abundant in prairies, cabin clearings, and river bank openings northward to the lower Mackenzie (*Miss E. Taylor,* O; *McConnell,* O), and Great Bear Lake (*Richardson,* O), but apparently confined to the country west of the Paleozoic boundary. — East shore of L. Mamawi, no. 2471; Murdock Cr. district, no. 2475; Ft. Smith, no. 799; lower Slave R., no. 798. Great Slave L.: *Onion, Kennicott & Hardisty* (N); Hay R., *Hume,* no. 102666(O); N. W. shore, *Bedford* (O).

Erysimum parviflorum Nutt. — Occasional northward to the lower Mackenzie (*McConnell,* O), mainly confined to the Paleozoic or younger areas. In the Wood Buffalo Park it grows on dry prairies and bluffs. — Yellowknife R., Great Slave L., *Russell* (O) (resembles *E. coarctatum* Fern., but has much smaller flowers).

Rorippa obtusa (Nutt.) Britt. — Apparently rare, and known in the Mackenzie basin only from a crevice on a granite hill in the Peace River delta. — East shore of L. Mamawi, no. 2514.

Rorippa palustris (L.) Bess. var. **glabrata** (Lunell) Victorin. — See Jour. Bot. **42:** 225 (1924), and Contrib. Lab. Bot. Univ. Montreal, no. 17 (1930). — Common on the wet shores of lakes and sloughs northward to Great Slave Lake, and known on Great Bear Lake (*J. M. Bell,* O). Noted by Richardson, under *Nasturtium palustre,* "to shores of the Arctic Sea." — Calumet, Athabaska R., nos. 801, 802. L. Athabaska: Sand Pt., no. 4548; Camsell Portage, no. 6174; Cornwall Bay, no. 6493. Upper Slave R. lowland, nos. 800, 2506, 2507, 2509. Great Slave L.: Resolution, *Onion, Kennicott & Hardisty* (N); Keith Isl., no. 805; Fairchild Pt., no. 804; Yellowknife Bay, no. 803; N. W. shore, *Bedford* (O); 12 mi. E. of Moraine Pt., *Bedford* (O).

Rorippa palustris (L.) Bess. var. **hispida** (Desv.) Rydb. — Occasional in the Salt Plain region of the Wood Buffalo Park.

Barbarea orthoceras Ledeb. — See Rhod. **11:** 134–41 (1909). — Common or occasional on stony and sandy shores about the great lakes, and known also on the Mackenzie (*Richardson,* O). — Lake Athabaska: near Sand Pt., no. 4511; N. shore of Ellis Bay, no. 6123; Crackingstone Pt., *J. W. Tyrrell,* no. 2310(O) (*B. vulgaris* of Tyrrell's list); Fishhook Bay, no. 6580. Great Slave L.: islands, E. arm, nos. 790, 791; Taltheilei Narrows, no. 793; Fairchild Pt., nos. 792, 794, 795; Yellowknife Bay, no. 789; N. W. shore, *Bedford* (O); Ft. Rae, *Russell* (O).

Cardamine pratensis L. var. **palustris** Wimm. & Grab. — See Rhod. **22:** 9–11 (1920). — An arctic species known in our region only in the northern and northeastern districts. — Lake Athabaska: N. shore, *J. W. Tyrrell,* no. 2314(O) (*C. pratensis* var. *angustifolia* of J. M. Macoun's Contr.). Great Slave L.: Taltheilei Narrows, no. 807; N. W. shore, *Bedford* (O).

Cardamine pennsylvanica Muhl. — Common in upland muskegs and sloughs northward at least to the Wood Buffalo Park, but scarcely extending eastward of the Paleozoic boundary. Noted in Fl. Bor.-Am. "to the shores of the Arctic Sea." — Chipewyan, no. 4701; Shelter Pt., L. Athabaska, no. 806.

Arabis lyrata L. — Common or occasional in upland meadows and on dry ridges or beaches northward to Lake Athabaska and the Wood Buffalo Park. Noted in Fl. Bor.-Am., under *Sisymbrium arabidoides,* north to Lat. 68°. — Clearwater R., *J. M. Macoun,* nos. 1724, 1725(O). Lake Athabaska: Shelter Pt., nos. 787, 788; near Sand Pt., nos. 4555,

4560; mouth of Charlot R., no. 6549; 5 mi. E. of Poplar Pt., no. 6652; near E. end of L. Athabaska, *J. W. Tyrrell,* no. 100741(O).

Arabis lyrata L. var. **kamchatica** Fisch. — This appears to be the common form of the species on sandy beaches and in shore rock crevices about Lake Athabaska. — Charlot Pt., nos. 6132, 6238; shore of main lake just west of Ellis Bay, no. 6266; mouth of Charlot R., no. 6334; 5 mi. E. of Poplar Pt., no. 6684; 2 mi. E. of Wolverine Pt., no. 6706; ancient beach ridges just E. of Wolverine Pt., no. 6748.

Arabis hirsuta (L.) Scop. — Common in dry prairies, clearings, and open woods northward to Lake Athabaska and the Wood Buffalo Park. Also known on the lower Mackenzie (*Onion,* N). — Lake Athabaska: W. shore of Ellis Bay, no. 6162; Charlot Pt., no. 6245; near mouth of Charlot R., no. 6364; hills N. W. of Cornwall Bay, no. 6534. Fort Resolution, *Dutilly,* no. 100(G).

Arabis retrofracta Grab. — *A. Holboellii* of some Amer. auth. — Occasional in dry prairies, open woods and turfy slopes northward to the lower Mackenzie (*Onion,* N). Notes in Fl. Bor.-Am. under *Turritis patula* and *T. retrofracta,* "to lat. 68°," probably all refer to this species. — Lake Athabaska: Shelter Pt., no. 796; Charlot Pt., no. 6081; Cornwall Bay, no. 6446. Fort Smith, *Miss E. Taylor,* no. 1683 (O); Windy Pt., Great Slave L., *Hume,* no. 102665(O).

Arabis divaricarpa A. Nels. — *A. brachycarpa* of auth. — Apparently occasional though widespread in our region, and also known from the Mackenzie (*Miss E. Taylor,* O). — Clearwater R., *J. M. Macoun,* no. 1665(O). Lake Athabaska: Chipewyan, nos. 6067, 6068; N. shore of Ellis Bay, no. 6111; Charlot Pt., no. 6139.

Arabis Drummondi Gray. — Occasional in prairies and open woods in the Wood Buffalo Park. The note in Fl. Bor.-Am., under *Turritis glabra,* and in Macoun's Cat. under *A. perfoliata,* "as far north as lat. 64°" may refer to this species.

Arabis arenicola (Richards.) Gel. — Known in our region from a single collection on Lake Athabaska. — North shore of L. Athabaska, *J. W. Tyrrell,* no. 34262(O) (*A. humifusa* var. *pubescens* of Tyrrell's list).

SARRACENIACEAE

Sarracenia purpurea L. — See Bartonia, **15:** 1–6 (1933). — Found growing abundantly in a wet muskeg near the south shore of Lake Athabaska, but otherwise very little known in the Mackenzie basin. Noted in Fl. Bor.-Am. as "probably common throughout Canada, and as far north as Bear Lake." Apparently no Richardson material has ever reached American herbaria, but MacFarlane, in Das Pflanzenreich,

4: 110: 34, cited a specimen "Fort Chipewyan (Franklin)," which is probably at least part of the basis for the Richardson record. In his long list of plants observed in 1875 John Macoun includes the pitcher plant in his section IV, "Peace and Athabasca Rivers east of the Rocky Mountains," but no specimens are available to support his record. — Athabaska Lake; muskeg about 3 mi. W. of Ennuyeuse Cr., no. 6974.

DROSERACEAE

Drosera rotundifolia L. — Common in wet, mossy muskegs in the pre-Cambrian country about Lake Athabaska but rare or occasional west of the Paleozoic boundary. Noted by Richardson "as far north as the Arctic Circle." — Lake Athabaska: Shelter Pt., nos. 778, 779; Sand Pt., no. 4533; Charlot Pt., no. 6308; muskeg N. E. of Cornwall Bay, no. 6541; 2 mi. W. of Ennuyeuse Cr., no. 7010. Great Slave L.: *R. Bell,* no. 23170(O); S. W. and N. shores, *Howe,* no. 91976(O).

Drosera anglica L. — Occasional to common on sandy lake and pond shores about Lake Athabaska, but otherwise unknown in the Mackenzie basin. — Lake Athabaska: Shelter Pt., nos. 780, 4426; Sand Pt., no. 4641; William Pt., no. 6854; about 3 mi. W. of Ennuyeuse Cr., no. 6969.

SAXIFRAGACEAE

Saxifraga Aizoon Jacq. — *Chondrosea Aizoon* (Jacq.) Haw. — An arctic species known in our region only on calcareous rocks at the eastern end of Great Slave Lake where it is common in crevices. — Fairchild Pt., nos. 818, 819, 820, 821, 822.

Saxifraga aizoides L. — *Leptasea aizoides* (L.) Haw. — An arctic and alpine species known in the Mackenzie basin east of the mountains only on Great Slave and Great Bear Lakes (*J. M. Bell,* O). — Fairchild Pt., Great Slave L., no. 823.

Saxifraga tricuspidata Rottb. — *Leptasea tricuspidata* (Rottb.) Haw. — Abundant on rock ridges and ancient beaches throughout the pre-Cambrian region and occasional farther westward. Forms with nearly or quite entire leaves are occasional and suggest *S. austromontana* Wiegand. Harper's unverifiable record for the latter species at Chipewyan may have been based upon one of these forms. — Lake Athabaska: Chipewyan, no. 6055; Shelter Pt., nos. 825, 830, 831, 832; Charlot Pt., no. 6105; near mouth of Charlot R., no. 6335; 5 mi. E. of Poplar Pt., no. 6643. Along the Quatre Fourches R., no. 826; E. shore of L. Mamawi, no. 2568; upper Slave R. lowland, no. 2567. Great Slave L.: Resolution, *Kennicott* (N); Caribou Isl., *Seton & Preble,* no. 78329(O); Taltheilei Narrows, no. 827; Maufelly Pt., no. 824; Fair-

child Pt., nos. 828, 829; Ft. Reliance, nos. 833, 834; S. W. and N. shores, *Howe*, no. 91970(O); Windy Pt., *Hume*, no. 102667(O); N. W. shore, *Bedford* (O); Yellowknife R., *Russell* (O). Parry's Falls, Lockhart R., *J. W. Tyrrell*, no. 23166(O); Artillery L., *J. W. Tyrrell*, no. 23167(O); and *Seton & Preble*, no. 78330(O).

Heuchera Richardsonii R. Br. — See Rhod. **35:** 111–19 (1933). — Common on dry bluffs, prairies, and rocky hills northward at least to the Wood Buffalo Park, and known on the upper Mackenzie (*Dutilly*, G). Noted by Richardson from "lat. 54°–64°." Scarcely extending into the pre-Cambrian country. — Lake Athabaska: Shelter Pt., no. 848; near Sand Pt., no. 4635. E. shore of L. Mamawi, no. 2550; along Quatre Fourches R., no. 847.

Mitella nuda L. — Common in rich spruce or spruce-poplar woodlands and timbered muskegs northward to the Mackenzie (*Onion, Kennicott & Hardisty*, N), but apparently occasional east of the Paleozoic boundary. — Calumet, Athabaska R., no. 816; along the lower Firebag R., no. 6038. Lake Athabaska: Shelter Pt., no. 817; Charlot Pt., no. 6302. Upper Slave R. lowland, nos. 815, 2562; vicinity of Ft. Smith, *Miss E. Taylor*, no. 21(G, O).

Chrysosplenium tetrandrum Fries. — An arctic and subarctic species occasional throughout most of our region, usually growing in muskegs. — Taltheilei Narrows, Great Slave L., no. 814.

Parnassia multiseta (Ledeb.) Fern. — *P. palustris* of auth. — See Rhod. **28:** 211 (1926). — Common in muskegs, willow slough margins, and on wet lake shores throughout our region, and known northward to the lower Mackenzie (*Stringer*, O), and Great Bear Lake (*J. M. Bell*, O). — Lake Athabaska: Shelter Pt., nos. 840, 841, 4422; near Sand Pt., no. 4630. Upper Slave R. lowland, nos. 2553, 2554; along Smith Portage Rd., no. 842; Slave R., *Miss E. Taylor*, no. 25(G). Great Slave L.: *R. Bell*, no. 23164(O); Fairchild Pt., nos. 843, 844, 845; Yellowknife Bay, no. 846; S. W. and N. shores, *Howe*, no. 91969(O); N. W. shore, *Bedford* (O).

Parnassia montanensis Fern. & Rydb. — Occasional on slough margins and wet lake shores in our region, but scarcely known elsewhere in the Mackenzie basin outside the mountains. — Calumet, Athabaska R., no. 838; Shelter Pt., L. Athabaska, no. 837; Fairchild Pt., Great Slave L., no. 839.

Parnassia Kotzebuei Cham. & Schl. — A northwestern arctic species known only in the pre-Cambrian parts of our region. It grows on stony shores. — Axis Lake, near the east end of L. Athabaska, *Campbell*, no. 132437(O). Great Slave L.: Taltheilei Narrows, no. 836; Fairchild Pt., no. 835.

Ribes oxyacanthoides L. — *Grossularia oxyacanthoides* (L.) Mill. — Common on rocky hills and in prairies and open woods northward at least to Great Slave Lake. — Lac la Biche, no. 6007; Waterways, no. 2531; along lower Firebag R., no. 6024. Lake Athabaska: Shelter Pt., nos. 855, 856; near Sand Pt., no. 4521; Charlot Pt., nos. 6140, 6281; Cornwall Bay, no. 6605; near Fond du Lac, *J. W. Tyrrell,* no. 8687(O). East shore L. Mamawi, no. 2537; upper Slave R. lowland, nos. 852, 2542; Ft. Smith, *Seton & Preble,* no. 78578(O) (*R. setosum* of Seton's list); lower Slave R., no. 854. Great Slave L.: Resolution, *Kennicott* (N); Fairchild Pt., nos. 850, 853.

Ribes hudsonianum Richards. — Common in rich woods and timbered muskegs northward to Great Slave Lake, and at least occasional at Great Bear Lake (*J. M. Bell,* O), and on the Mackenzie (*Kennicott,* N). — Calumet, Athabaska R., no. 864; along lower Firebag R., nos. 6013, 6023, 6034a. Lake Athabaska: Chipewyan, *J. W. Tyrrell,* no. 100833(O); Shelter Pt., nos. 861, 863; Charlot Pt., no. 6157; 5 mi. E. of Poplar Pt., no. 6693. Along the Quatre Fourches R., no. 860; upper Slave R. lowland, nos. 859, 862, 2525; Ft. Smith, *Miss E. Taylor* (G, O); and *Seton & Preble,* no. 78326(O). Great Slave L.: Resolution, *Onion, Kennicott & Hardisty* (N); Caribou Isl., *Seton & Preble,* no. 78327(O); Fairchild Pt., no. 865; Yellowknife Bay, no. 858; S. W. shore, *Brooke* (O); N. W. shore, *Bedford* (O) ?. Crystal Isl., Artillery L., *J. W. Tyrrell,* no. 100834(O).

Ribes lacustre (Pers.) Poir. — *Limnobotrya lacustris* (Pers.) Rydb. — Occasional in rich woods and timbered muskegs northward in the Paleozoic or younger country to the Wood Buffalo Park. Eastward in the pre-Cambrian country it has been found only in a calcareous district on Lake Athabaska. Noted in Fl. Bor.-Am., "Throughout Canada to Fort Franklin and Bear Lake . . ." — Hills near base of Cornwall Bay, L. Athabaska, nos. 6428, 6566.

Ribes glandulosum Grauer. — *R. prostratum* L'Hér. — Occasional in woods and thickets. Noted by Preble "throughout the country from the Athabaska north at least to Great Bear Lake," but the writer has seen no material from beyond the south shore of Great Slave Lake. — Lake Athabaska: Shelter Pt., no. 849; Charlot Pt., no. 6160. Clut L., near the east end of L. Athabaska, *Campbell,* nos. 132439, 132440. Slave R., *Miss E. Taylor,* no. 8666(O); Ft. Resolution, *Kennicott* (N).

Ribes triste Pall. — Common in rich woods and timbered muskegs throughout the region and extending to the lower Mackenzie (*Kennicott,* N; *McConnell,* O). — McMurray, no. 866; along Athabaska R. about 15 mi. below McMurray, no. 868; Calumet, Athabaska R., no. 867;

along lower Firebag R., nos. 6011, 6021. Lake Athabaska: Chipewyan, *J. W. Tyrrell*, no. 85012(O) (*R. rubrum* of Tyrrell's list); Charlot Pt., no. 6149; Camsell Portage, no. 6189; Fishhook Bay, no. 6579; near mouth of Archibald R., no. 6758. Ft. Smith, *Seton & Preble*, no. 78328(O). Great Slave L.: Fairchild Pt., no. 870.

ROSACEAE

Sorbus sitchensis Roem. — Primarily a cordilleran species, but known eastward in the Lesser Slave Lake district (*John Macoun*, O) and on Lake Athabaska. In the latter region it is occasional on beach ridges about the north shore, and abundant in similar places on the south shore. — Lake Athabaska: Sand Pt., nos. 4470, 4584, 4659; Elliot Pt., no. 6425; about 3 mi. E. of Wolverine Pt., no. 6799; 2 mi. W. of Ennuyeuse Cr., no. 6930.

Amelanchier florida Lindl. — See Rhod. **14:** 117 (1912). — A common shrub of dry woods, prairies, river banks, and rocky hills northward at least to the Wood Buffalo Park. Noted by Preble as extending "nearly to the limit of the woods," and Richardson noted it (as *A. ovalis*) "to the Saskatchewan and Mackenzie Rivers." It is a variable species with forms in our region strongly suggesting *A. humilis* Wieg. — Athabaska R., "near the rapids," *Miss E. Taylor*, no. 8289 (O); Waterways, no. 2649; Calumet, no. 932. Lake Athabaska: Chipewyan, no. 6065; Shelter Pt., nos. 929, 933, 4466; near Sand Pt., no. 4519; N. W. angle of *L. Athabaska, J. W. Tyrrell*, no. 100894(O) (*A. alnifolia* of Tyrrell's list); Charlot Pt., no. 6084; Fishhook Bay, no. 6588; 5 mi. E. of Poplar Pt., no. 6670; 2 mi. W. of Ennuyeuse Cr., nos. 6931, 6933. East shore of L. Mamawi, no. 2654; along Quatre Fourches R., no. 927; upper Slave R. lowland, nos. 928, 2652; Ft. Smith, no. 930; and *Seton & Preble*, no. 78587(O) (*A. alnifolia* of Seton's list); Resolution, *Kennicott* (N). Numbers 4466 and 4519 cited above approach *A. humilis*. In Wiegand's revision of this group he doubtfully determines the Taylor specimen and also one from Resolution collected by Preble (N. E.) as *A. humilis*.

Amelanchier humilis Wieg. — Occasional on sandy lake and pond margins about Lake Athabaska, and apparently commoner southward in the Athabaska River valley. Otherwise unknown in the Mackenzie basin except for the doubtfully determined Preble specimen noted under *A. florida*. — McMurray, nos. 7078, 7089; along lower Firebag R., no. 6043. Lake Athabaska: Sand Pt., no. 4515; 5 mi. S. E. of Wolverine Pt., no. 6829.

Rubus idaeus L. var. **canadensis** Richards. — *R. subarcticus* (Greene) Rydb. — See Rhod. **21:** 89 (1919). — The common red

raspberry of open woods, clearings, prairies, rocky hills, and lake beaches. Preble's note under *R. strigosus,* "nearly throughout the forested region," probably refers to this variety for the most part. Tyrrell's record under the same name on Stone River east of Lake Athabaska, and Harper's under *R. melanolasius* between Athabaska and Great Slave Lakes may also belong here. — McMurray, no. 7104. Lake Athabaska: Shelter Pt., nos. 883, 884, 888, 889; Sand Pt., nos. 4520, 4522; N. shore of Ellis Bay, no. 6119; Cornwall Bay, no. 6567; 5 mi. E. of Poplar Pt., no. 6641. East shore of L. Mamawi, no. 2635; upper Slave R. lowland, nos. 881, 887, 2627; Ft. Smith, no. 885; lower Slave R., no. 882. Great Slave L.: Caribou Isl., *Seton & Preble,* no. 78324(O) (*R. strigosus* of Seton's list); Fairchild Pt., no. 886; Ft. Rae, *Russell* (O).

Rubus idaeus var. **strigosus** (Michx.) Maxim. — See Rhod. **21:** 89 (1919). — Known in our region only in the Wood Buffalo Park, but apparently occasional northward to the lower Mackenzie (*Onion,* N; *Miss E. Taylor,* O).

Rubus Chamaemorus L. — Widely distributed in muskegs, but commonest about Great Slave Lake and in the pre-Cambrian country southward. — Lake Athabaska: Shelter Pt., nos. 891, 893; Sand Pt., no. 4600; Camsell Portage, no. 6195; hill country about 4 mi. S. E. of Wolverine Pt., no. 6788. Great Slave L.: Resolution, *Kennicott* (N); and *Miss E. Taylor* (G, N, O); Taltheilei Narrows, no. 892; Fairchild Pt., no. 890; Yellowknife Bay, no. 895; S. W. and N. shores, *Howe,* no. 91975(O); mouth of Little Buffalo R., *Brooke* (O); 12 mi. E. of Moraine Pt., *Bedford* (O); near Ft. Rae, *Russell* (O). Artillery L., *J. W. Tyrrell,* no. 23165(O).

Rubus pubescens Raf. — *R. triflorus* Richards. — See Rhod. **11:** 236 (1909). — Common to abundant in shady woods northward to Lake Athabaska and the Wood Buffalo Park, and known also on the Mackenzie (*Kennicott,* N; *Onion,* N). — Calumet, Athabaska R., no. 879; along lower Firebag R., no. 6047. Lake Athabaska: Camsell Portage, no. 6201; Cornwall Bay, no. 6501; along Archibald R., near its mouth, no. 6761. Along the Quatre Fourches R., no. 880; Gov. Hay Camp, Slave R., no. 2619.

Rubus acaulis Michx. — *R. arcticus* L. var. *grandiflorus* Hook. — Common to abundant in rich woods and muskeg thickets northward to Great Bear Lake (*J. M. Bell,* O) and the Mackenzie (*Kennicott,* N). — Lower Athabaska R., *Kennicott* (N). Lake Athabaska: N. shore, *J. W. Tyrrell,* no. 5776(O); Shelter Pt., nos. 872, 875; Camsell Portage, no. 6197. Upper Slave R. lowland, nos. 871, 873, 2638, 2639; vicinity of

Ft. Smith, *Miss E. Taylor* (G, O); lower Slave R., *Brooke* (O). Great Slave L.: Resolution, *Kennicott* (N); Taltheilei Narrows, nos. 874, 878; Fairchild Pt., no. 877; Yellowknife Bay, no. 876; S. W. and N. shores, *Howe,* no. 91974(O); N. W. shore, *Bedford* (O).

Fragaria glauca (S. Wats.) Rydb. — Common to abundant in dry open woods, prairies, clearings, and on rocky hills northward to Lake Athabaska and the Wood Buffalo Park; at least occasional at Great Bear Lake (*J. M. Bell,* O) and on the Mackenzie (*Onion,* N). Citations in Fl. Bor.-Am. of Mackenzie basin plants under *F. virginiana* and *F. canadensis* probably belong here, as well as Harper's record for *F. cuneifolia* at Grand Rapids on the Athabaska. Rydberg named several of the specimens cited below as *F. pauciflora,* but the writer has been unable to draw any good distinctions between this species and *F. glauca,* if indeed the latter can be maintained entirely separate from the widespread *F. virginiana.* — Lower Athabaska R., *Kennicott* (N); along the Athabaska just below MacKay, no. 6004; Calumet, nos. 971, 972; along lower Firebag R., no. 6046. Lake Athabaska: Chipewyan, no. 6059; Cornwall Bay, no. 6439; Black R., *J. W. Tyrrell,* no. 7168(O) (*F. canadensis* of Tyrrell's list). East shore of L. Mamawi, no. 2609; along the Quatre Fourches R., no. 974; upper Slave R. lowland, nos. 970, 2606; Ft. Smith, no. 969; and *Miss E. Taylor,* no. 7169(O); and *Seton & Preble,* no. 78574(O).

Fragaria vesca L. var. **americana** Porter. — Known in our region only in the southern districts and along the Peace River in the Wood Buffalo Park. — Waterways, no. 2610.

Potentilla arguta Pursh. — *Drymocallis agrimonioides* (Pursh) Rydb. — Noted in Fl. Bor.-Am. in the "woody country as far north as lat. 65°" but the writer has seen no material from beyond Lake Athabaska and the Wood Buffalo Park where it is common in dry prairies and rock crevices. Harper's record for *Drymocallis corymbosa* on the "Taltson River below Napie Falls" probably belongs here. — McMurray, no. 7092; Calumet, Athabaska R., no. 948. Lake Athabaska: Chipewyan, no. 4703; Shelter Pt., nos. 949, 4430; Charlot Pt., no. 6261; Cornwall Bay, no. 6437. East shore of L. Mamawi, no. 2690.

Potentilla millegrana Engelm. — Known in our area only from a clearing along the upper Slave River. — Government Hay Camp, no. 2681.

Potentilla norvegica L. var. **hirsuta** (Michx.) Lehm. — *P. monspeliensis* of auth. — See Bibl. Bot. **16:** 404 (1908). — Common to abundant in wet meadows, prairies, and areas of disturbed soil generally, whether natural or artificial, northward at least to Great Slave

Lake. Noted in Fl. Bor.-Am. at Great Bear Lake. — Lower delta of Athabaska R., no. 963. Lake Athabaska: Chipewyan, no. 7034; Shelter Pt., nos. 964, 965; Sand Pt., no. 4544; Camsell Portage, no. 6173; Charlot Pt., no. 6246; Cornwall Bay, nos. 6433, 6450; 3 mi. W. of Ennuyeuse Cr., no. 6959. East shore of L. Mamawi, no. 2692; upper Slave R. lowland, nos. 2698, 2699, 2701; Ft. Smith, no. 966. Great Slave L.: Keith Isl., no. 968; Yellowknife Bay, no. 967; S. W. and N. shores, *Howe,* no. 91973(O).

Potentilla nivea L. — An arctic species known in our region only in the pre-Cambrian country where it inhabits crevices in exposed rocky hills. — Lake Athabaska: Chipewyan, no. 4675; Charlot Pt., nos. 6087, 6094. Parry Falls, Lockhart R., *J. W. Tyrrell,* no. 23160(O); Artillery L., *J. W. Tyrrell,* no. 23159(O).

Potentilla nivea L. var. **subquinata** Lange. — *P. nipharga* Rydb. — Occasional in rock crevices and on stony beaches about Athabaska and Great Slave Lakes, and known on the lower Mackenzie (*Onion,* N, type of *P. nipharga*). — Lake Athabaska: Chipewyan, no. 6057; Sand Pt., no. 4530; hills N. and N. E. of Cornwall Bay, nos. 6525, 6576. Great Slave L.: island in E. arm, no. 939; Taltheilei Narrows, no. 941; Fairchild Pt., no. 940; Yellowknife R., *Russell* (O).

Potentilla nivea L. var. **pentaphylla** Lehm. — *P. quinquefolia* Rydb. — Apparently rare or occasional in the pre-Cambrian country about Great Slave Lake where it grows in rock crevices. — Caribou Isl., *Seton & Preble,* nos. 78575, 78576(O); Taltheilei Narrows, no. 938.

Potentilla multifida L. — Common on shore rocks on the north side of Lake Athabaska, and at least occasional at Great Slave Lake and on the Mackenzie (*Dutilly,* G; *Miss E. Taylor,* O). — Lake Athabaska: Chipewyan, nos. 6061, 7036; Shelter Pt., nos. 936, 4464; Charlot Pt., nos. 6130, 6237; Fishhook Bay, no. 6578. Ft. Smith, *Seton & Preble* (N, O); Yellowknife Bay, Great Slave L., no. 935.

Potentilla pulcherrima Lehm. — A northern plains species known in our region only in dry prairies in the Wood Buffalo Park.

Potentilla pennsylvanica L. — See Rhod. **37:** 286–92 (1935). — Common or occasional on dry prairies, sandy ridges, and rocky hills northward at least to Lake Athabaska and the Wood Buffalo Park. Known also at Great Slave Lake and noted by Richardson at Bear Lake. — Lake Athabaska: Chipewyan, no. 7022; Shelter Pt., no. 934; near Wabba L., no. 6476; Cornwall Bay, no. 6559. East shore of L. Mamawi, nos. 2718, 2719. Resolution, *Onion, Kennicott & Hardisty* (N). Taltson R., below Tethul R., *Harper,* no. 100280(O) (*P. glabrella* of Harper's list. This specimen is labeled "Rocher River, Alberta

. . . Aug. 12, 1914," but the published note refers to the Taltson River with the same date, and it is presumed that the latter is correct.)

Potentilla pectinata Raf. — Known in the Mackenzie basin only in the pre-Cambrian parts of our region where it inhabits rock crevices. — Lake Athabaska: Chipewyan, no. 7035; near Sand Pt., nos. 4487, 4636; Charlot Pt., nos. 6240, 6381; Cornwall Bay, no. 6548; Fishhook Bay, no. 6582. Taltheilei Narrows, Great Slave L., no. 937.

Potentilla Anserina L. — *Argentina Anserina* (L.) Rydb. — Abundant in damp meadows, the drier parts of slough margins, and on some river and lake shores northward to Great Slave Lake, but scarcely extending into the pre-Cambrian country. Known on the Mackenzie (*Onion,* N; *Miss E. Taylor,* G, O), and noted by Richardson "to the extreme Arctic regions." — Calumet, Athabaska R., no. 945; Shelter Pt., L. Athabaska, no. 942; E. shore of L. Mamawi, no. 2682; upper Slave R. lowland, nos. 944, 946, 2683; Ft. Smith, no. 943. Great Slave L.: Resolution, *Miss E. Taylor,* no. 100931(O); Stony Isl., *J. W. Tyrrell,* no. 23161(O); Keith Isl., no. 947; Hay R., *Hume,* no. 102668(O).

Potentilla palustris (L.) Scop. — *Comarum palustre* L. — Common at the margins of sloughs and muskeg ponds throughout the region to Great Bear Lake (*J. M. Bell,* O) and the Barren Lands. — Lower Athabaska R., *Kennicott* (N); Egg L., Athabaska delta, *Harper,* no. 45(G). Lake Athabaska: Shelter Pt., nos. 954, 955; Sand Pt., no. 4579; mouth of Charlot R., no. 6313; Cornwall Bay, no. 6625; William Pt., no. 6845; muskeg 3 mi. W. of Ennuyeuse Cr., no. 6963; pond shore about 2 mi. W. of Ennuyeuse Cr., no. 6985. Great Slave L.: N. shore of McLeod Bay, no. 957; Fairchild Pt., nos. 956, 958, 959; Yellowknife Bay, no. 953; Ft. Rae, *Russell* (O). Casba L., *J. W. Tyrrell,* no. 23161(O).

Potentilla fruticosa L. — *Dasiphora fruticosa* (L.) Rydb. — A common shrub of muskegs and rock crevices in the Wood Buffalo Park and about Great Slave Lake, but not known thus far on Lake Athabaska. Tyrrell noted it near Fond du Lac, but no specimen is available. Preble gives its northern range as "to the limit of the forest," and it has been collected at Great Bear Lake (*J. M. Bell,* O) and on the lower Mackenzie (*Onion,* N). Ft. Smith, no. 961. Great Slave L.: Caribou Isl., *Seton & Preble,* no. 78323(O); Taltheilei Narrows, no. 962; Yellowknife Bay, no. 960; S. W. and N. shores, *Howe,* no. 91972(O); N. W. shore, *Bedford* (O); Ft. Rae, *Russell* (O); Great Slave L., *R. Bell,* no. 23158(O); and *Kennicott* (N).

Potentilla tridentata Ait. — *Sibbaldiopsis tridentata* (Ait.) Rydb. — Noted by Richardson "throughout the woody country, . . .

as far as lat. 64°," but otherwise not known north of Lake Athabaska and the Wood Buffalo Park. It grows on dry sandy ridges and dunes, sandy lake beaches and in rock crevices. — Lower Athabaska R., *Kennicott* (N). Lake Athabaska: Shelter Pt., nos. 950, 951, 952, 4429; near Sand Pt., no. 4538; rocky point at N. W. entrance to Black Bay, no. 6418; dunes about 2 mi. E. of Wolverine Pt., no. 6749; sand hills about 4 mi. S. E. of Wolverine Pt., no. 6780; dunes just E. of Ennuyeuse Cr., no. 6926. Woodcock Portage, Black R., *J. W. Tyrrell,* no. 8030 (O). Upper Slave R. lowland (Gov. Hay Camp district), no. 2729.

Chamaerhodos Nuttallii Pickering. — See Rhod. **37:** 284–5 (1935). — Known in the Mackenzie basin east of the Rocky Mountains only from a single locality on the north shore of Lake Athabaska where it is abundant on outcrops of conglomerate rocks. — Charlot Pt., nos. 6228, 6248.

Geum macrophyllum Willd. var. **perincisum** (Rydb.) Raup. — *G. perincisum* Rydb. — *G. oregonense* Rydb., not Scheutz. — See Rhod. **33:** 172–6 (1931). — Common in prairies and sloughs northward to Great Bear Lake (*J. M. Bell,* O) and the Mackenzie (*Onion, Kennicott & Hardisty,* N), but not thus far collected in the pre-Cambrian regions. — Upper Slave R. lowland, nos. 923, 2589, 2591; Ft. Smith district, nos. 922, 925, 926; lower Slave R., no. 924.

Geum strictum Ait. — Common in dry prairies and occasional in cabin clearings northward to the Wood Buffalo Park, and known also on the Mackenzie (*Miss E. Taylor,* O). — McMurray, no. 7094; E. shore of L. Mamawi, no. 2579.

Geum triflorum Pursh. — *Sieversia triflora* (Pursh) R. Br. — Common in dry upland prairies and rocky hills in the Wood Buffalo Park and southwestward. The Richardson plant probably came from the vicinity of Chipewyan, but there is no other record for the species in the pre-Cambrian. — Lake Athabaska, *Richardson* (O); Gov. Hay Camp district, Slave R., no. 2587.

Dryas Drummondii Richards. — Known in our region about Great Slave Lake and on the north shore of Lake Athabaska, and apparently confined to calcareous rocks. Known on the Mackenzie (*Onion,* N), and given a wide range in the northwestern arctic regions by Richardson. — Lake Athabaska: Cornwall Bay, no. 6550. Great Slave L.: Resolution, Kennicott (N); Fairchild Pt., nos. 911, 912, 913, 914; Jones Pt., *Hume,* no. 102669(O); N. W. shore, *Bedford* (O).

Dryas integrifolia Vahl. — An arctic and alpine species common about Great Slave Lake and northward. — Great Slave L.: *R. Bell,* no. 23156(O); Caribou Islands, *Seton & Preble,* no. 78322(O); Taltheilei

Narrows, nos. 915, 917, 919; Fairchild Pt., nos. 916, 918, 920, 921; S. W. and N. shores, *Howe*, no. 91971(O); N. W. shore, *Bedford* (O). Last woods, Artillery L., *Seton & Preble*, no. 78321(O); barren ground, Artillery L., *J. W. Tyrrell*, no. 23157(O).

Rosa acicularis Lindl. — An abundant and exceedingly variable species throughout the wooded country. The writer has been unable to maintain var. *Bourgeauiana*, although this is commonly done with many northern specimens; the shape of the fruits is extremely variable, both with age and locality, and the only trend which seems worthy of note is to be found about Lake Athabaska and southward. Here a form with much elongated fruits has been collected several times (nos. 2658, 2659, 2660, 4456, 4415, 7113, cited below), and may be referable to var. *lacorum* Erlanson (See Papers Mich. Acad. Sci., Arts and Letters, **5**: 77–94). Most of the material cited in Fl. Bor.-Am. for the Mackenzie basin under *R. blanda*, *R. Sayii*, and *R. majalis* probably belongs here. — McMurray, nos. 7113, 7114; Calumet, Athabaska R., nos. 903, 910; Reed Portage, upper Athabaska delta, no. 2660; lower Athabaska R., *Kennicott* N). Lake Athabaska: Shelter Pt., nos. 898, 899, 907, 908, 4445, 4446; Sand Pt., nos. 4651, 4680; N. shore of Ellis Bay, no. 6121; Charlot Pt., no. 6403; hills S. of Wabba L., no. 6478; 2 mi. E. of Wolverine Pt., no. 6708; mouth of Archibald R., no. 6768; sand hills 4 mi. S. E. of Wolverine Pt., no. 6774; William Pt., no. 6855; 2 mi. W. of Ennuyeuse Cr., nos. 6950, 6951, 7006. East shore of L. Mamawi, nos. 2658, 2659, 2667, 4415; along Quatre Fourches R., no. 905; upper Slave R. lowland, nos. 906, 2674; Fitzgerald, *R. M. Anderson* (N); Ft. Smith, no. 901; and *Seton & Preble*, no. 78325(O). Great Slave L.: Stony Isl., *J. W. Tyrrell*, no. 23162(O); Taltheilei Narrows, no. 897; Maufelly Pt., no. 904; Fairchild Pt., nos. 896, 900, 909; Yellowknife Bay, no. 902; 12 mi. E. of Moraine Pt., *Bedford* (O); near Ft. Rae, *Russell* (O).

Rosa Woodsii Lindl. — Common on dry prairies and bluffs in the southern and southwestern parts of the Mackenzie basin, but not definitely known in any part of the pre-Cambrian country or north of the Wood Buffalo Park. Noted in Fl. Bor.-Am. "North of the Saskatchewan, as far as Bear Lake." — McMurray, nos. 7059, 7091; E. shore of L. Mamawi, nos. 2680, 4416.

Prunus demissa (Nutt.) D. Dietr. — Common in the southern and southwestern parts of the Mackenzie basin, in upland woods and on dry river bluffs. Notes in Fl. Bor.-Am. under *Cerasus virginiana* and *C. serotina* probably refer to this species and give the northern limit at Great Slave Lake, lat. 62°. The writer has seen no material, however,

from beyond the lower Athabaska, and it should be noted that both Seton and Preble place the northern limit in this district also. — Waterways, no. 2569; McMurray, no. 7082; along Athabaska R. just below MacKay, no. 6000.

Prunus pennsylvanica L.f. — Common in the southern and southwestern portions of the Mackenzie basin and northward to Lake Athabaska and the Wood Buffalo Park. Preble recorded it at Great Slave Lake when he wrote, "along the Athabaska and Slave Rivers and about the great lakes into which they flow." — Waterways, no. 2573; along Athabaska R. just below MacKay, no. 6002; along lower Firebag R., no. 6042. Lake Athabaska: Shelter Pt., nos. 975, 976, 4443; Sand Pt., nos. 4469, 4594; N. shore of Ellis Bay, no. 6122; Charlot Pt., no. 6216; Fishhook Bay, no. 6581; 2 mi. E. of Wolverine Pt., no. 6712; sand hills 4 mi. S. E. of Wolverine Pt., no. 6775; 2 mi. W. of Ennuyeuse Cr., no. 6946. Upper Slave R. lowland, no. 2572.

LEGUMINOSAE

Astragalus frigidus (L.) Gray var. **americanus** (Hook.) Wats. — *Phaca americana* (Hook.) Rydb. — Common or occasional about Great Slave Lake and in the Wood Buffalo Park but not known elsewhere in our region. It is also known on the upper Mackenzie (*Dutilly*, G). — Great Slave L.: base of Maufelly Pt., no. 992; Fairchild Pt., no. 993.

Astragalus canadensis L. — Known in the Mackenzie basin from a single collection along the lower Athabaska River. — River bank, McMurray, no. 7049.

Astragalus adsurgens Pall. — Occasional on sandy ridges and prairies in the Wood Buffalo Park and southwestward.

Astragalus hypoglottis L. — Common in rather dry prairies in the Wood Buffalo Park and southwestward.

Astragalus alpinus L. — *Tium alpinum* (L.) Rydb. — Rather common in upland woods and prairies northward at least to Lake Athabaska and the Wood Buffalo Park. Known also at Great Bear Lake (*J. M. Bell*, O) and the Mackenzie (*Onion*, N). — Lake Athabaska: island on N. shore about 6 mi. E. of Chipewyan, no. 4672; Cornwall Bay, nos. 6440, 6565, 6610. Ft. Smith, nos. 994 (coll. *Mrs. Conibear*), 995.

Astragalus neglectus (T. & G.) Sheldon. — Known in the Mackenzie basin from a single collection on the lower Athabaska River. — River bank, McMurray, no. 7056.

Astragalus eucosmus Robinson. — Apparently rare or occasional, but of wide range in the Mackenzie basin, extending northward to Great

Bear Lake (*J. M. Bell,* O). — Dolomitic hill near base of Cornwall Bay, L. Athabaska, no. 6574; island in Slave R. (at 30th base line), no. 991.

Astragalus tenellus Pursh. — *Homalobus tenellus* (Pursh) Britton. — Apparently occasional on dry banks and prairies northward to the lower Mackenzie (*Richardson,* O; *Miss E. Taylor,* O), but not known east of the Paleozoic boundary.

Astragalus yukonis Jones. — Known in the Mackenzie basin from a single collection on the lower Athabaska River. — River bank, Calumet, no. 990.

Oxytropis retrorsa Fern. — See Rhod. **30:** 140–1 (1928). — Known in our region from a single collection near the lower Athabaska River. — Along woods road near McMurray, no. 7096.

Oxytropis hudsonica (Greene) Fern. — See Rhod. **30:** 142 (1928). — An arctic species known in our region only in the Lockhart basin. — Barren grounds, Artillery L., *J. W. Tyrrell,* no. 23150(O) (*O. campestris* var. *caerulea* of Tyrrell's list).

Oxytropis gracilis (A. Nels.) K. Schum. — *Aragallus gracilis* A. Nels. — See Univ. Wyo. Publ. Bot. **1:** 109–21 (1926) for a treatment of this and the following. — Apparently occasional in the northwestern part of our region, and known on the lower Mackenzie (*Miss E. Taylor,* O). — N. W. shore of Great Slave L., *Bedford* (O).

Oxytropis Lamberti Pursh. — Apparently rare or occasional and known in the Mackenzie basin only on Great Slave Lake. Harper's record for this species at "Salt River, September 8" cannot be verified. — S. W. and N. shores of Great Slave L., *Howe,* nos. 91977, 91978(O).

Oxytropis viscidula (Rydb.) Tidestr. — *Aragallus viscidulus* Rydb. — Known thus far in the Mackenzie basin east of the mountains only on Great Slave Lake where it grows on shingle beaches. — Fairchild Pt., nos. 980, 981, 982; N. W. shore, *Bedford* (O).

Oxytropis splendens Dougl. — *Aragallus splendens* (Dougl.) Greene. — Common in dry upland prairies and on sandy ridges and plains, chiefly west of the Paleozoic boundary and northward at least to Great Slave Lake. Noted by Richardson as extending to Bear Lake. The writer has included var. *Richardsonii* which seems of doubtful value. — Calumet, Athabaska R., no. 979. Great Slave L.: Resolution, *Onion, Kennicott & Hardisty* (N); Ft. Reliance, no. 978; first point N. of Gypsum Pt., *Hume,* no. 102671(O).

Glycyrrhiza lepidota (Nutt.) Pursh. — John Macoun noted this species as occurring northward to Lake Athabaska, but the only authentic record for the Mackenzie basin is from specimens collected on the

lower Athabaska River in 1935. — River bank near McMurray, no. 7048.

Hedysarum alpinum L. var. **americanum** Michx. — Common in upland open woods, prairies, river banks, and lake beaches about Great Slave Lake and in the Wood Buffalo Park, but not found thus far on Lake Athabaska. Known on Great Bear Lake (*J. M. Bell*, O) and the lower Mackenzie (*McConnell*, O; *Miss E. Taylor*, O). — McMurray, no. 7057; Calumet, Athabaska R., no. 998; Government Hay Camp district, Slave R., no. 2807. Great Slave L.: Keith Isl., no. 996; N. shore of McLeod Bay, no. 1000; Fairchild Pt., nos. 997, 999, 1001, 1002; S. W. and N. shores, *Howe*, no. 91991 (O); N. W. shore, *Bedford* (O).

Hedysarum Mackenzii Richards. — Occasional in open woods and thickets and on river banks northward to the lower Mackenzie (*Onion*, N) and Great Bear Lake (*J. M. Bell*, O), but not found thus far in the pre-Cambrian country. — Upper Slave R. lowland, nos. 1004, 1005. Great Slave L.: base of Maufelly Pt., no. 1003; N. W. shore, *Bedford* (O).

Vicia americana Muhl. — Abundant in prairies, open woods, and cabin clearings northward at least to Great Slave Lake, and noted by Richardson to Great Bear Lake. Although common just west of the Paleozoic boundary it has been collected only once in the pre-Cambrian country. — Lower Athabaska R., *Kennicott* (N); Calumet, nos. 1007, 1008; near Pt. La Roche, S. shore of L. Athabaska, no. 7013; E. shore of L. Mamawi, nos. 2783, 4410; upper Slave R. lowland, nos. 2796, 2798; Ft. Smith, no. 1006; Hay R., Great Slave L., *Hume*, no. 102670 (O).

Vicia americana Muhl. var. **angustifolia** Nees. — Occasional in sloughs and on sand ridges in the Wood Buffalo Park, and possibly only a form of the species. — Upper Slave R. (30th base line), no. 1010; lower Slave R., no. 1009.

Lathyrus ochroleucus Hook. — Abundant in prairies, clearings, and dry open woods northward at least to the Wood Buffalo Park and noted in Fl. Bor.-Am. as extending to Great Bear Lake. Scarcely known east of the Paleozoic boundary. — Waterways, no. 2749; McMurray, *Dutilly*, no. 119(G); along Athabaska R. about 6 mi. below McMurray, no. 987; Calumet, no. 984. Lake Athabaska: Shelter Pt., nos. 983, 985; near Pt. La Roche, S. shore, no. 7014. Along Quatre Fourches R., no. 989; upper Slave R. lowland, nos. 988, 2745; Ft. Smith, no. 986; and *Miss E. Taylor*, no. 5507(O); and *Seton & Preble*, nos. 78319, 78320 (O). Resolution, *Onion, Kennicott & Hardisty* (N).

GERANIACEAE

Geranium Bicknellii Britton. — See Rhod. **37**: 295–301 (1935). — Occasional to common in upland woods and clearings northward at least to Lake Athabaska and the Wood Buffalo Park. In the latter it is abundant in recently burned areas. — Lake Athabaska: near Sand Pt., no. 4480; hills near base of Cornwall Bay, nos. 6436, 6517, 6562; N. shore, short distance W. of Fond du Lac, *J. W. Tyrrell*, no. 101142(O) (*G. carolinianum* of Tyrrell's list). Fort Smith, no. 1011.

LINACEAE

Linum Lewisii Pursh. — Common or occasional on dry prairies and bluffs northward to Great Bear Lake (*J. M. Bell*, O) and the Mackenzie (*Dutilly*, G), but not known east of the Paleozoic boundary. Noted by Richardson (under *L. perenne*) "as far north as the shores of the Arctic Sea."

CALLITRICHACEAE

Callitriche palustris L. — Apparently occasional in small pools and ponds northward at least to Great Slave Lake. — McMurray, no. 7097. Lake Athabaska: Shelter Pt., no. 1023; Sand Pt., no. 4568; along William R., no. 6876. Great Slave L.: N. W. shore, *Bedford* (O).

Callitriche hermaphroditica L. — See Rhod. **25**: 211 (1923), and Vierteljahrssch. Nat. Ges. Zür. **53**[4]: 548 (1909). — Common in ponds and slow streams in the Wood Buffalo Park, but very little collected elsewhere in the Mackenzie basin. Noted in Fl. Bor.-Am. "as far north as Bear Lake, lat. 66°." — Mamawi Cr., no. 2812.

EMPETRACEAE

Empetrum nigrum L. — Abundant in rocky woods and on sandy beaches and dunes throughout the pre-Cambrian parts of our area, but only occasional in the Wood Buffalo Park. — Lake Athabaska: Shelter Pt., nos. 1014, 1015, 1016; Sand Pt., no. 4586; Charlot Pt., no. 6156; Fishhook Bay, no. 6590; 2 mi. E. of Wolverine Pt., no. 6838; dunes just E. of Ennuyeuse Cr., no. 6921. Great Slave L.: Taltheili Narrows, no. 1017; Maufelly Pt., no. 1018; Fairchild Pt., nos. 1013, 1019, 1020; Ft. Reliance, no. 1021; S. W. and N. shores, *Howe*, no. 91979 (O); 12 mi. E. of Moraine Pt., *Bedford* (O). Last woods, Artillery L., *Seton & Preble*, no. 78390(O).

BALSAMINACEAE

Impatiens Noli-tangere L. — See Bull. No. **74**:, Nat. Mus. Can. 149 (1935). — Known in our region only in the lowlands about the western end of Lake Athabaska, where it is common or occasional in rich woods and damp thickets. Mackenzie basin records in Fl. Bor.-

Am. under *I. fulva*, "as far north as Bear Lake; lat. 66°," probably refer to this species. — East shore of L. Mamawi, no. 4412; Chipewyan, no. 4690.

Impatiens sp. — Apparently too young for definite determination. Although they are mere seedlings, some of the plants have produced some cleistogamous flowers and fruit. All of the material (about 70 plants) came from a space about 10 inches in diameter, from about 80 seeds which still cling to the roots. Found in the moss mat of a timbered, upland muskeg in the Wood Buffalo Park.

RHAMNACEAE

Rhamnus alnifolia L'Hér. — Known in the Mackenzie basin only along the lower Athabaska River where it is common in wet lowland woods. — McMurray, no. 7121; Calumet, no. 1022; along lower Firebag R., no. 6020.

GUTTIFERAE

Hypericum majus (Gray) Britton. — Known in the Mackenzie basin only on damp sandy shores about Lake Athabaska, where it is common to abundant. — Lake Athabaska: Shelter Pt., nos. 1024, 1025, 4436; Sand Pt., no. 4550; 5 mi. S. E. of Wolverine Pt., no. 6818; 2 mi. W. of Ennuyeuse Cr., no. 6980.

CISTACEAE

Hudsonia tomentosa Nutt. var. **intermedia** Peck. — Abundant on sandy beach ridges and dunes about Lake Athabaska, and noted by Richardson "as far north as Slave Lake." Otherwise unknown in our region except for the Kennicott specimen cited below. — Lower Athabaska R., *Kennicott* (N). Lake Athabaska: Shelter Pt., no. 1026; near Sand Pt., no. 4618; shore of main lake just W. of Ellis Bay, no. 6273; 2 mi. E. of Wolverine Pt., no. 6715; just W. of Ennuyeuse Cr., no. 6942.

Lechea intermedia Leggett var.[1] — Known in the Mackenzie basin from a single locality on the south side of Lake Athabaska, where it grows on burned-over sand plains among young Banksian pines. — Near Archibald R., S. of Wolverine Pt., no. 6745.

VIOLACEAE

Viola nephrophylla Greene. — Known in our region from a single locality in the Wood Buffalo Park, and elsewhere in the Mackenzie basin only in the Peace River region.

Viola palustris L. — Occasional in wet woods and muskegs along

[1]A distinctive form of the species, to be described in a forthcoming monograph of the genus by Dr. A. R. Hodgdon.

the lower Athabaska River, and on the north shore of Lake Athabaska. A specimen in Herb. G is labeled "Arct. Am. Back? Syn. Fl. N. Am." and "Capt. Back coll."; but no locality is given, and it is difficult to correlate it with any of the records in Back's list. — Along lower Firebag R., no. 6025. Lake Athabaska: Sand Pt., no. 4554; Camsell Portage, no. 6200.

Viola renifolia Gray var. **Brainerdii** (Greene) Fern. — Occasional to common in rich woods northward to the Mackenzie (*Onion, Kennicott & Hardisty,* N; *Miss E. Taylor,* G, O), but scarcely known east of the Paleozoic boundary. Richardson's record for *V. blanda,* "as high north as Fort Franklin, in lat. 66°," probably belongs here, and there is a Hooker specimen of *V. renifolia,* var. *Brainerdii* in Herb. G originally labeled *V. blanda* which presumably came from the north, although no locality is given. — Along lower Athabaska R. about 15 mi. below McMurray, no. 1028; along lower Firebag R., no. 6026; Chipewyan, no. 4677.

Viola rugulosa Greene. — Apparently rather widely distributed in the Mackenzie basin west of the Paleozoic boundary. It is common in open upland woods in the Wood Buffalo Park and southward. — Lower Athabaska R., *Miss E. Taylor,* no. 2370(O); Waterways, no. 2829.

Viola adunca J. E. Smith. — Common in upland semi-open prairies and rock crevices northward to the Mackenzie River (*Kennicott,* N) and Great Bear Lake (*J. M. Bell,* O), but not known far east of the Paleozoic boundary. — Waterways, no. 2821; along Athabaska R. just below MacKay, no. 6003. Lake Athabaska: Chipewyan, *J. W. Tyrrell,* no. 101167(O) (probably *V. canina* var. *sylvestris* of Tyrrell's list; the list cites Fond du Lac as the locality, but the date on the specimen is June 19, 1893, at which time Tyrrell was at Chipewyan); Shelter Pt., no. 1029. East shore of L. Mamawi, no. 2824.

ELAEAGNACEAE

Elaeagnus commutata Bernh. — *E. argentea* Pursh, not Moench. — Abundant on dry river bluffs, and occasional on dry upland prairies and sandy lake shores northward to the Mackenzie (*Miss E. Taylor,* G, N, O; *Dutilly,* G), but not known in the pre-Cambrian country. — Calumet, Athabaska R., no. 1033.

Shepherdia canadensis (L.) Nutt. — *Lepargyrea canadensis* (L.) Greene. — Common in woods and thickets northward to Great Slave Lake, and known on the lower Mackenzie (*Miss E. Taylor,* O). — Calumet, Athabaska R., no. 1044. Lake Athabaska: Shelter Pt., no. 1043; near Sand Pt., no. 4668; Charlot Pt., no. 6219; Cornwall Bay, no. 6598. East shore of L. Mamawi, no. 2841; Quatre Fourches R., no. 1035;

upper Slave R. lowland, nos. 1036, 2835, 2836; Ft. Smith, no. 1034; and *Seton & Preble*, no. 78389(O). Great Slave L.: near Caribou Isl., *Seton & Preble*, no. 78388(O); Taltheilei Narrows, no. 1041; Fairchild Pt., nos. 1037, 1039, 1040, 1042, 1045; Yellowknife Bay, no. 1038; S. W. and N. shores, *Howe*, no. 91982(O); N. W. shore, *Bedford* (O).

ONAGRACEAE

Epilobium angustifolium L. — *Chamaenerion angustifolium* (L.) Scop. — Abundant throughout the timbered region, in open woods, clearings, prairies, and burned areas. In the pre-Cambrian it grows on rocky hills and ancient lake beaches. — Calumet, Athabaska R., nos. 1061, 1062, 1069. Lake Athabaska: Shelter Pt., nos. 1057, 1059, 1060, 1067; just E. of Charlot Pt., no. 6375; 2 mi. E. of Wolverine Pt., no. 6795. Quatre Fourches R., no. 1066; upper Slave R. lowland, nos. 1065, 2862; Ft. Smith, no. 1053 (*Mrs. Conibear* coll.), 1056. Great Slave L.: Taltheilei Narrows, no. 1058; Fairchild Pt., nos. 1054, 1055, 1068; Ft. Reliance, no. 1064; Yellowknife Bay, no. 1063; Hay R., *Hume*, no. 102672(O); 12 mi. E. of Moraine Pt., *Bedford* (O).

Epilobium latifolium L. — *Chamaenerion latifolium* (L.) Sweet. — Chiefly an arctic and alpine species known in our region only on Great Slave Lake and in the Lockhart basin, where it grows on sandy shores and in dry woods. — Great Slave L.: base of Maufelly Pt., no. 1073; Fairchild Pt., nos. 1071, 1072; Ft. Reliance, nos. 1070, 1074; N. W. shore, *Bedford* (O). Last Woods, Artillery L., *Seton & Preble*, no. 78331(O).

Epilobium palustre L. — Common in muskegs and wet meadows northward to Lake Athabaska and the Wood Buffalo Park, and known on Great Slave and Great Bear Lakes (*J. M. Bell*, O). — Lake Athabaska: Chipewyan, no. 4698; Shelter Pt., no. 1050; near Sand Pt., no. 4638; 2 mi. W. of Ennuyeuse Cr., no. 6979. East shore of L. Mamawi, no. 2845; Murdock Cr. district, no. 2855. Great Slave L.: Fairchild Pt., nos. 1051, 1052.

Epilobium palustre L. var. **monticola** Haussk. — Common or occasional about Lake Athabaska and along the upper Slave River. Part of the material cited in Fl. Bor.-Am. under *E. palustre* var. *albiflora*, "as far north as lat. 64°," probably belongs here. — Lake Athabaska: Shelter Pt., nos. 1046, 4427; near Sand Pt., no. 4474; along Charlot R. near its mouth, no. 6361; 5 mi. E. of Poplar Pt., no. 6695. Government Hay Camp district, Slave R., no. 2844.

Epilobium glandulosum Lehm. var. **adenocaulon** (Haussk.) Fern. — *E. adenocaulon* Haussk. — See Rhod. **20:** 35 (1918). — Common in sloughs, wet meadows, and on lake shores northward to Lake

Athabaska and the Wood Buffalo Park, and at least occasional on Great Slave Lake. — McMurray, no. 7076; lower delta of Athabaska R., no. 1049. Lake Athabaska: Shelter Pt., nos. 1047, 1048; N. of Cornwall Bay, no. 6495; along Ennuyeuse Cr., near its mouth, no. 6927. East shore of L. Mamawi, no. 2870; Murdock Cr. district, no. 2863; N. W. shore of Great Slave L., *Bedford* (O).

Epilobium leptocarpum Haussk. var. **Macounii** Trel. — Known in the Mackenzie basin east of the Rocky Mountains only from the type material, which was collected "On moist rocks, Lake Athabaska" by John Macoun, September 3, 1875. Macoun's journal shows that he was in the Athabaska delta on Sept. 3, somewhere within 25 miles of the lake, and in a country notable for the absence of "rocks." In his Catalogue he wrote "Lake Athabaska, near Fort Chipewyan, Lat. 59°," which further confuses the exact locality from which the type came. — Moist rocks, L. Athabaska. *John Macoun*, no. 8931(G, O) (*E. minutum* of Macoun's Cat.)

Circaea alpina L. — Occasional to common in rich woods northward to the Athabaska River delta, but unknown elsewhere in the Mackenzie basin, east of the Rocky Mountains. — McMurray, no. 7107; Reed Portage, upper Athabaska delta, no. 2843.

HALORAGIDACEAE

Myriophyllum exalbescens Fern. — *M. spicatum* L. of auth. — See Rhod. **21:** 120 (1919). — Noted in Fl. Bor.-Am. "as far north as the Bear Lake," and abundant in shallow slough ponds and slow streams northward at least to Great Slave Lake. — Mamawi Cr., no. 2882. Lake Athabaska: pond just N. of Cornwall Bay, no. 6623; 2 mi. W. of Ennuyeuse Cr., no. 7005. Murdock Cr. district, no. 2884; Fairchild Pt.; Great Slave L., no. 1075.

HIPPURIDACEAE

Hippuris vulgaris L. — Common in shallow ponds and sluggish streams throughout the region, and known on the lower Mackenzie (*Kennicott*?, N). — Lower delta of Athabaska R., no. 1077. Lake Athabaska: Shelter Pt., no. 1078; muskeg N. of Cornwall Bay, no. 6496; along Archibald R., S. of Wolverine Pt., no. 6737. Upper Slave R. lowland, nos. 2877, 2878, 2879. Great Slave L.: Taltheilei Narrows, no. 1076; Fairchild Pt., no. 1079; E. shore of Charlton Bay, no. 1081; Yellowknife Bay, no. 1080; 12 mi. E. of Moraine Pt., *Bedford* (O).

ARALIACEAE

Aralia nudicaulis L. — Common to abundant in open woods northward at least to Lake Athabaska and the Wood Buffalo Park, and noted

in Fl. Bor.-Am. "throughout the woody country to lat. 64°." — Calumet, Athabaska R., no. 1083. Lake Athabaska: Shelter Pt., nos. 1084, 1085; Sand Pt., no. 4561; Charlot Pt., no. 6142.

UMBELLIFERAE

Cicuta occidentalis Greene. — Occasional in wet meadows northward at least to the Wood Buffalo Park, but not known east of the Paleozoic boundary. Part of the material cited under *C. maculata* in Fl. Bor.-Am., "between lat. 54° and 64°," probably belongs here, as may also part of Harper's unverified records on the Tazin River and near the mouth of the Taltson. — Calumet, Athabaska R., no. 1087; lower delta of the Athabaska, no. 1086; E. shore of L. Mamawi, nos. 2890, 4403; 30th base line district, upper Slave R., no. 1088.

Cicuta mackenzieana, sp. nov. PLATE 197[1]

Herba perennis erecta robusta, 4–10 dm. alta; radix ovoidea ad breviter oblonga, recta, infra radicibus pluribus incrassatis et supra fibrosis instructa; folia inaequaliter bipinnata, plerumque purpurascentia, habitu erecto et stricto, segmentis ultimis anguste lanceolatis vel ellipticis, plerisque 1–5 mm. latis, vel segmentis foliorum inferiorum circa 1 cm. latis acute dentatis dentibus 3–5 per cm., foliolis saepe imperfecte divisis; umbellae ad 15 cm. latae, ramis 7–14 (plerumque 8–12); umbellulae 1.5–2.5 cm. (pleraeque circa 2 cm.) latae, pedicellis 25–45 subaequantibus; involucra bracteis paucis anguste lanceolatis vel nullis, involucella bracteolis paucis anguste lanceolatis acuminatis; fructus latior quam longus (1.5–2.2 mm. × 2–3 mm.) ad commissuram non constrictus, costis lateralibus majoribus.

Sandy margin of a lagoon near the south shore of Lake Athabaska about 1½ miles west of Ennuyeuse Creek, Aug. 25, 1935, no. 6976 (Type, G).

The existence of a distinctive subarctic species of *Cicuta* was recently suggested by Dr. Nicholas Polunin while studying material collected by himself at Fort Churchill, Hudson Bay. However, not only these but also earlier specimens at the Gray Herbarium from the same region had been collected early in the season and were without mature fruit. Plants collected by the writer on Lake Athabaska in 1935, and elsewhere in the central part of the Mackenzie basin on former occasions, now provide a good series whereby the form may be properly described. *Cicuta mackenzieana* appears to be rather common on sandy lake and swamp margins about Lake Athabaska, and is at least occasional in the Wood

[1]PLATE 197. *Cicuta mackenzieana* Raup. Part of type collection from a lagoon near the south shore of L. Athabaska about 1½ mi. W. of Ennuyeuse Cr., no. 6976; details of umbellet × 3, and of fruits × 8.

Buffalo Park and about Great Slave Lake. The following specimens are referred to it: margin of lagoon near mouth of Archibald R., south shore of L. Athabaska, no. 6764; muskeg margin about 3 mi. west of mouth of Ennuyeuse Cr., no. 6964; sandy shore of William R., just above its mouth, no. 6861; muskeg margin at Shelter Pt., L. Athabaska, no. 1089; Axis Lake, near E. end of L. Athabaska, *Campbell,* no. 132402 (O); slough margin near Moose (Eight) L., Wood Buffalo Park, no. 2892 (cited as *C. occidentalis* in *Bot. Invest.* etc.); Yellowknife Bay, Gr. Slave L., no. 1093. The Hudson Bay specimens noted above may now be cited as typical, and are as follows: Fort Churchill, *J. M. Macoun,* no. 79261 (distributed as *C. virosa*), "Hudson Bay," *Burke,* and Churchill, *Polunin,* no. 73. Material noted in Fl. Bor.-Am. under *C. virosa,* "between lat. 54° and 64°," probably belongs here, at least in part.

With its fruits shorter than broad this species suggests *C. vagans* Greene which has orbicular fruits, but it differs from *C. vagans* in having them unconstricted at the commissure. In the latter character it resembles the eastern *C. maculata* L., but *C. maculata,* as well as its western relative, *C. occidentalis,* has distinctly oblong fruits. *C. mackenzieana* differs from all of these forms, further, in having smaller fruits, umblets of many nearly equal branches (25–45, usually 30–40, as against the usual number of 30 or less very unequal ones in the other species), and in having very narrowly lanceolate, saliently dentate leaflets which are purplish-tinged and strict in habit.

Cicuta bulbifera L. — Apparently rare or occasional in the Mackenzie basin, and known thus far only from the Wood Buffalo Park and the south side of Lake Athabáska. It grows on sandy lake shores in the latter place. — Two mi. W. of Ennuyeuse Cr., L. Athabaska, no. 6977.

Sium suave Walt. — *S. cicutaefolium* Gmel. of auth. — See Rhod. **17:** 131 (1915). — Common in wet meadows and on marshy slough margins northward at least to Great Slave Lake, but extending east of the Paleozoic boundary only short distances. Part of the material noted in Fl. Bor.-Am. under *Cicuta virosa,* north to lat. 64°, appears to have been this species. — Lower delta of Athabaska R., no. 1090; Shelter Pt., L. Athabaska, no. 1091; E. shore of L. Mamawi, nos. 2898, 4408; upper Slave R. lowland, nos. 1092, 2902. Great Slave L.: Resolution, *Kennicott* (N); N. W. shore, *Bedford* (O); Ft. Rae, *Bedford* (O).

Heracleum lanatum Michx. — Occasional to common in clearings and semi-open prairies in the southern part of the Mackenzie basin, extending northward at least to the Wood Buffalo Park. In Fl. Bor.-

Am. it is given the somewhat anomolous range, "as far north as the Mackenzie River in lat. 58°"; and there is an Onion, Kennicott & Hardisty specimen in Herb. N. upon which no locality is mentioned, but it *might* have come from the Mackenzie. — McMurray, no. 7119.

CORNACEAE

Cornus canadensis L. — *Chamaepericlymenum canadense* (L.) Aschers. & Graebn. — Usually noted as occurring throughout the wooded country, but judging by the writer's observations it is not common about the eastern arm of Great Slave Lake. It is most abundant in open woods. — Calumet, Athabaska R., nos. 1095, 1098. Lake Athabaska: Shelter Pt., no. 1094; near Sand Pt., no. 4621; Charlot Pt., no. 6397; 5 mi. E. of Poplar Pt., no. 6637; sand hills about 4 mi. S. E. of Wolverine Pt., no. 6783. Quatre Fourches R., no. 1097; Gov. Hay Camp district, no. 2916; Ft. Smith, no. 1096; and *Miss E. Taylor* (G, N, O); and *Seton & Preble,* no. 78332(O). Great Slave L.: N. W. shore, *Bedford* (O); near Ft. Rae, *Russell* (O); Hay R., *Hume,* no. 102673(O).

Cornus stolonifera Michx. — Common on stream banks and lake shores northward to the Mackenzie, mostly west of the Paleozoic boundary, but occasional on the north shore of Lake Athabaska where it has been found only in dolomitic areas. — McMurray, no. 7077; along the Athabaska a few miles below McMurray, no. 1100; Calumet, no. 1102. Lake Athabaska: thicket on hillside S. of Wabba L., no. 6484; near base of Cornwall Bay, no. 6575. East shore of L. Mamawi, no. 2910; along the Quatre Fourches R., no. 1099; upper Slave R. lowland, nos. 1103, 1104, 2909; near upper Smith rapids, no. 1101.

Cornus stolonifera Michx. var. **Baileyi** (Coult. & Evans) Drescher. — *C. Baileyi* Coult. & Evans. — This form is apparently confined to the southwestern part of the Mackenzie basin and is known in our region only in the Wood Buffalo Park.

PYROLACEAE

Chimaphila umbellata (L.) Bartr. var. **occidentalis** (Rydb.) Blake. — See Rhod. **19:** 237–44 (1917). — Known in the Mackenzie basin east of the Rocky Mountains only on Lake Athabaska. It grows in sandy spruce woods and is rather common on some parts of the south shore. — Chipewyan, no. 7020; 2 mi. E. of Wolverine Pt., no. 6798; Turnor Pt., no. 6840.

Moneses uniflora (L.) Gray. — Common in rich woods and timbered muskegs northward at least to Great Bear Lake (*J. M. Bell,* O) and the upper Mackenzie (*Kennicott,* N; *Miss E. Taylor,* G, N, O), but

apparently only occasional about Lake Athabaska. — Calumet, Athabaska R., no. 1106; near base of Cornwall Bay, L. Athabaska, no. 6477; near upper Smith Rapids, no. 1105. Great Slave L.: *R. Bell,* no. 23203(O); Fairchild Pt., nos. 1107, 1108, 1109; S. W. and N. shores, *Howe,* no. 91962(O); Windy Pt., *Hume,* no. 102676(O); Ft. Rae, *Russell* (O).

Pyrola minor L. — *Erxlebenia minor* (L.) Rydb. — Known in our region only on Lake Athabaska where it is rather common in damp thickets at sandy lagoon margins near the lake. Apparently rare elsewhere in the Mackenzie basin except in the Rocky Mountains. — Lake Athabaska: Sand Pt., no. 4558; mouth of Charlot R., no. 6319; mouth of Archibald R., no. 6771.

Pyrola secunda L. — *Ramischia secunda* (L.) Garcke. — Common in rich woods and timbered muskegs northward to Great Bear Lake (*J. M. Bell,* O) and the Mackenzie River (*Miss E. Taylor,* O; *Dutilly,* G). — Calumet, Athabaska R., no. 1131. Lake Athabaska: Shelter Pt., nos. 1132, 1133; near Sand Pt., no. 4598; Charlot Pt., nos. 6296, 6402; mouth of Archibald R., no. 6767. Upper Slave R. lowland, nos. 1130, 2926, 2927. Great Slave L.: *Kennicott* (N); near Caribou Isl., *Seton & Preble,* no. 78346(O) (*P. secunda* var. *pumila* of Seton's list); Fairchild Pt., nos. 1134, 1135, 1136; Yellowknife Bay, no. 1137; N. W. shore, *Bedford* (O).

Pyrola chlorantha Sw. — See Rhod. **22:** 49 (1920). — Common in upland woods and damp thickets northward at least to the upper Mackenzie (*Miss E. Taylor,* G, O), and noted by Richardson at Great Bear Lake. — Calumet, Athabaska R., no. 1126; lower Athabaska R., *Kennicott* (N). Lake Athabaska: mouth of Charlot R., no. 6332; Charlot Pt., no. 6398; 5 mi. E. of Poplar Pt., no. 6638; near mouth of Archibald R., no. 6762; 2 mi. W. of Ennuyeuse Cr., no. 6943. Great Slave L.: *Richardson* (G); base of Maufelly Pt., no. 1125; Fairchild Pt., nos. 1123, 1124, 1127, 1128, 1129; N. W. shore, *Bedford* (O).

Pyrola grandiflora Rad. — An arctic and alpine species known in our region only in the pre-Cambrian country, and westward on Great Slave Lake. — Lake Athabaska: west shore of Ellis Bay, no. 6164; Charlot Pt., nos. 6221, 6225, 6294; N. shore (probably near Fond du Lac), *J. W. Tyrrell,* no. 15780(O) (*P. rotundifolia* var. *pumila* of Tyrrell's list). Slave R., *Richardson* (G). Great Slave L.: near Caribou Isl., *Seton & Preble,* no. 78347(O); S. W. and N. shores, *Howe,* no. 91963(O). Last woods, Artillery L., *Seton & Preble,* no. 78348(O); and *J. W. Tyrrell,* no. 23205(O) (*P. pumila* of Tyrrell's list); shore of Artillery L., about 3 mi. N. of Lockhart R., *J. W. Tyrrell,* no. 23206(O) (*P. pumila* of Tyrrell's list).

Pyrola asarifolia Michx. — Common in poplar and spruce woods northward at least to the Wood Buffalo Park, and known on the Mackenzie (*Onion,* N). Although occasional about Lake Athabaska it has not been found elsewhere east of the Paleozoic boundary. — McMurray, no. 7085; Calumet, Athabaska R., no. 1112. Lake Athabaska: Chipewyan, *Richardson* (O) (*P. rotundifolia* of Fl. Bor.-Am. and Macoun's Cat., in part); Charlot Pt., no. 6396; 5 mi. E. of Poplar Pt., no. 6639a; mouth of Archibald R., no. 6770. Along the Quatre Fourches R., no. 1110?, 1113; near upper Smith Rapids, no. 1114; Ft. Smith, no. 1111.

Pyrola asarifolia Michx. var. **incarnata** (Fisch.) Fern. — Habitat similar to that of the species, but with a somewhat wider range throughout the wooded country. Earlier material has been named *P. borealis* by Rydberg, the type of which is a specimen collected on the Mackenzie River by *Onion* (N), but the writer has preferred to keep it as a variety of *P. asarifolia.* If it is raised to specific rank, an earlier name is available, *P. canadensis* H. Andres (Öst. Bot. Z. **64:** 250. 1914). — Calumet, Athabaska R., no. 1120. Lake Athabaska: hills N. E. of Cornwall Bay, no. 6529; 5 mi. E. of Poplar Pt., no. 6639. Upper Slave R. lowland, nos. 1115, 2949; vicinity of Ft. Smith, *Miss E. Taylor* (G, O). Great Slave L.: Taltheilei Narrows, nos. 1121, 1122; N. shore of McLeod Bay, no. 1116; base of Maufelly Pt., no. 1117; Fairchild Pt., nos. 1118, 1119; Windy Pt., *Hume,* no. 102675(O); N. W. shore, *Bedford* (O); near Ft. Rae, *Russell* (O). There are specimens in Herb.'s G and N, marked "King in Back's Voyage" or ". . . Journey," and originally labeled *P. rotundifolia.* Judging by the Botanical Appendix to Back's Narrative, they came from "Athabasca."

Pyrola elliptica Nutt. — Known thus far only in the central and southern parts of the Mackenzie basin, and in our region only at McMurray and on Lake Athabaska where it grows in damp sandy thickets or upland woods. — McMurray, no. 7084. Lake Athabaska: Sand Pt., no. 4557; 5 mi. E. of Poplar Pt., no. 6669.

Monotropa uniflora L. — Apparently rare or occasional in the Mackenzie basin, and known thus far only on Lake Athabaska and along the Slave River. — Lake Athabaska: woods along shore just E. of Chipewyan, no. 7040; rich woods on old sand beaches, 2 mi. W. of Ennuyeuse Cr., no. 6901. Slave R., *Miss E. Taylor* (G, O).

ERICACEAE

Ledum groenlandicum Oeder. — Common in muskegs throughout the wooded country. — Calumet, Athabaska R., no. 1157. Lake Athabaska: Shelter Pt., nos. 1158, 1161, 1162, 1163; Sand Pt., nos. 4525, 4593; N. shore of Ellis Bay, no. 6113; 5 mi. E. of Poplar Pt., no. 6692;

along Archibald R., S. of Wolverine Pt., no. 6735. Smith Portage, *Miss E. Taylor,* no. 59851(O). Great Slave L.: near Caribou Isl., *Seton & Preble,* no. 77357(O); island near Keith Isl., no. 1156; Taltheilei Narrows, nos. 1159, 1164; Fairchild Pt., nos. 1155, 1165, 1166; Yellowknife Bay, no. 1160; 12 mi. E. of Moraine Pt., *Bedford* (O); S. W. and N. shores, *Howe,* no. 91964(O). Last woods, Artillery L., *Seton & Preble,* no. 78358(O).

Ledum palustre L. — This plant is most commonly represented in the Mackenzie basin by its variety *decumbens,* but a form referable to the typical species was found in sandy pine woods on the south shore of Lake Athabaska. — About 3 miles E. of Wolverine Pt., no. 6807.

Ledum palustre L. var. **decumbens** Ait. — An arctic variety occasional in the Wood Buffalo Park and on Lake Athabaska, but commoner northward. It is found in muskegs. — Lake Athabaska: near Sand Pt., no. 4523. Great Slave L.: Caribou Isl., *Seton & Preble,* no. 78354(O) (*L. palustre* of Seton's list); Taltheilei Narrows, no. 1189; Fairchild Pt., nos. 1167, 1168; S. shore, *Brooke* (O). Near southern end of Artillery L., *J. W. Tyrrell,* no. 23199(O) (*L. palustre* of Tyrrell's list); Last Woods, Artillery L., *Seton & Preble,* no. 78355(O) (*L. palustre* of Seton's list); Clinton-Colden L., *J. W. Tyrrell,* no. 23198(O) (*L. palustre* of Tyrrell's list).

Rhododendron lapponicum (L.) Wahl. — An arctic species known in our region only on Great Slave Lake and in the Lockhart basin. It grows in muskegs and rock crevices. — Great Slave L.: *R. Bell,* no. 23209(O); Caribou Isl., *Seton & Preble,* no. 78360(O); Keith Isl., no. 1150; Taltheilei Narrows, no. 1151; Fairchild Pt., nos. 1148, 1149, 1152, 1153. Last woods, Artillery L., *J. W. Tyrrell,* nos. 23207, 23208 (O); and *Seton & Preble,* no. 78361(O).

Loiseleuria procumbens (L.) Desv. — An arctic and alpine species known in the Mackenzie basin east of the Rocky Mountains only on Great Bear Lake (*J. M. Bell,* O) and to the east of Great Slave Lake. — French L., Pike's Portage route, *J. W. Tyrrell,* no. 23200(O); Last woods, Artillery L., *J. W. Tyrrell,* no. 23201(O); and *Seton & Preble,* no. 78359(O).

Kalmia polifolia Wang. — Apparently confined to the more arctic parts of the timbered country, and extending somewhat into the Barren Lands. It has been collected on the Thelon River and in the Dubawnt drainage at Lat. 62°05′ (*J. W. Tyrrell,* O). The range given in Fl. Bor.-Am. is "extending beyond the woody regions, but scarcely, . . . to the Arctic Circle," and Preble states, "not noted south of Smith Landing [Fitzgerald]," and "It apparently extends north to the Barren

Grounds." It has proved to be quite common in muskegs about Lake Athabaska. — Lake Athabaska: near Sand Pt., no. 4529; Camsell Portage, no. 6175; 5 mi. E. of Poplar Pt., no. 6657; along Archibald R., S. of Wolverine Pt., no. 6731. Resolution, *Kennicott* (N).

Cassiope tetragona L. — An arctic and alpine species known in our region only in the Lockhart basin. Richardson gave its range as "From lat. 54° to the Arctic Islands," in Fl. Bor.-Am., but there is no other indication of its presence so far south except in the Rocky Mountains. — Shore of Casba L., *J. W. Tyrrell*, no. 23193(O).

Andromeda Polifolia L. — Common in muskegs throughout the pre-Cambrian country, and at least occasional southward and westward. — Lake Athabaska: Sand Pt., nos. 4516, 4527; Camsell Portage, no. 6192; Charlot Pt., no. 6300; mouth of Charlot R., no. 6320; about 5 mi. S. E. of Wolverine Pt., no. 6828; point about 4 mi. E. of Wolverine Pt., no. 6804; 2 mi. W. of Ennuyeuse Cr., no. 7012. Great Slave L.: Resolution, *Kennicott* (N); Caribou Isl., *Seton & Preble*, no. 78349 (O); Keith Isl., no. 1140; Taltheilei Narrows, nos. 1142, 1143, 1144; base of Maufelly Pt., no. 1147; Fairchild Pt., nos. 1141, 1145, 1146; S. W. and N. shores, *Howe*, no. 91965(O); N. W. shore, *Bedford* (O). Lockhart R., 3 mi. from Artillery L., *J. W. Tyrrell*, no. 23191(O); Last Woods, Artillery L., *Seton & Preble*, no. 78350(O); E. end of Clinton-Colden L., *J. W. Tyrrell*, no. 23192(O).

Chamaedaphne calyculata (L.) Moench. — Common in wet muskegs throughout the timbered country northward at least to Lake Athabaska and the Wood Buffalo Park. Apparently occasional on Great Slave Lake. Noted in Fl. Bor.-Am. "throughout the woody, and part of the barren country," and Preble states, "probably throughout the wooded area." — Lake Athabaska: Shelter Pt., nos. 1138, 1139; Sand Pt., no. 4526; Camsell Portage, no. 6190; 5 mi. E. of Poplar Pt., no. 6666; along Archibald R., S. of Wolverine Pt., no. 6736; N. shore, *J. W. Tyrrell*, no. 15519(O) (*Cassandra calyculata* of Tyrrell's list); "From Cumberland House to Fort Chipewyan," *Richardson* (O) (*Andromeda calyculata* of Fl. Bor.-Am., and *Cassandra calyculata* of Macoun's Cat.). Great Slave L.: Resolution, *Kennicott* (N); N. W. shore, *Bedford* (O).

Arctostaphylos Uva-ursi (L.) Spreng. — Common on sandy or rocky plains and hills, and in dry upland woods northward at least to Great Bear Lake (*J. M. Bell*, O). According to Preble it also extends into the Barren Lands. — Along the Athabaska just below McMurray, no. 1178; Calumet, nos. 1173, 1177; along the lower Firebag R., no. 6034. Lake Athabaska: Shelter Pt., nos. 1174, 1175, 1176, 4453;

Charlot Pt., no. 6078; Cornwall Bay, no. 6594; 2 mi. E. of Wolverine Pt., no. 6837; gravel dunes just E. of Ennuyeuse Cr., no. 6922. East shore of L. Mamawi, nos. 2999, 3000; along Quatre Fourches R., no. 1171; Ft. Smith, *Seton & Preble,* no. 78352(O). Great Slave L.: Resolution, *Kennicott* (N); near Caribou Isl., *Seton & Preble,* no. 78351(O); Taltheilei Narrows, nos. 1170, 1172; Fairchild Pt., nos. 1179, 1180, 1183; Ft. Reliance, no. 1182; Yellowknife Bay, no. 1181; and *Russell* (O); S. W. and N. shores, *Howe,* no. 91968(O); N. W. shore, *Bedford* (O); French L., Pike's Portage route, *J. W. Tyrrell,* no. 23188(O).

Arctostaphylos Uva-ursi (L.) Spreng. var. **adenotricha** Fern. & Macbr. — See Rhod. **16:** 211–13 (1914). — A cordilleran form of the species known eastward in the Mackenzie basin from a single locality on the north shore of Lake Athabaska. — Upper slopes of a dolomitic hill near the base of Cornwall Bay, no. 6604.

Arctostaphylos rubra (Rehder & Wilson) Fern. — *Mairania alpina* (red-fruited form) Britton & Rydb. — *Arctous alpina* Niedenz. var. *rubra* Rehder & Wilson. — See Rhod. **16:** 32 (1914). — Common about Great Slave Lake and northward but only occasional in the Wood Buffalo Park and on Lake Athabaska. It is usually found in muskeg timber. — Lake Athabaska: Charlot Pt., nos. 6224, 6299. Great Slave L.: *R. Bell,* no. 23148(O); Taltheilei Narrows, no. 1186; Fairchild Pt., nos. 1184, 1185, 1187, 1188; S. W. and N. shores, *Howe,* no. 91967(O); N. W. shore *Bedford* (O). Kipling L., Pike's Portage route, *J. W. Tyrrell,* no. 23190(O); Artillery L., 3 mi. N. of Lockhart R., *J. W. Tyrrell,* no. 23189(O); Last Woods, Artillery L., *Seton & Preble,* no. 78353(O).

Vaccinium canadense Richards. — *Cyanococcus canadensis* (Richards.) Rydb. — Common to abundant on sandy plains and rocky ridges northward to Lake Athabaska and the Wood Buffalo Park. Noted in Fl. Bor.-Am. as occurring north to Great Bear Lake, but the writer has seen no other record from beyond those cited below. — Athabaska R. below Pelican Rapids, *Harper,* no. 99015(O); Calumet, no. 1209; along the lower Firebag R., no. 6040. Lake Athabaska: Shelter Pt., nos. 1208, 1210, 1211; near Sand Point, no. 4619; Elliot Pt., no. 6426; 5 mi. E. of Poplar Pt., no. 6691; 2 mi. E. of Wolverine Pt., no. 6711; 2 mi. W. of Ennuyeuse Cr., no. 6934. Government Hay Camp district, Slave R., no. 2965.

Vaccinium uliginosum L. — See Rhod. **25:** 23–5 (1923). — Common in muskegs and on sandy ridges and plains about the great lakes but very little known west of the Paleozoic boundary in our region. It grows to a height of 2–3 feet and produces abundant fruit. — Lake

Athabaska: Shelter Pt., no. 4447; near Sand Pt., no. 4510; small island about 2 mi. E. of Crackingstone Pt., no. 6424; N. shore, near Old Man R., *J. W. Tyrrell,* no. 101370(O); 5 mi. E. of Poplar Pt., nos. 6655, 6690; gravelly dunes just E. of Ennuyeuse Cr., no. 6918; shore ridges 2 mi. W. of Ennuyeuse Cr., no. 6948. Great Slave L.: Keith Isl., no. 1216; Taltheilei Narrows, nos. 1214, 1219; Fairchild Pt., nos. 1215, 1217, 1218, 1221, 1222; N. W. shore, *Bedford* (O). Last woods, Artillery L., *J. W. Tyrrell,* no. 23111(O); and *Seton & Preble,* no. 78382(O).

Vaccinium Vitis-Idaea L. var. **minus** Lodd. — *Vitis-Idaea Vitis-Idaea* (L.) Britton. — Common to abundant in muskegs and dry sandy woods throughout the region. — Lake Athabaska: Shelter Pt., nos. 1191, 1192 and 1193; near Sand Pt., no. 4620; N. shore near Cypress Pt., *J. W. Tyrrell,* no. 101377(O); base of Cornwall Bay, no. 6595; 2 mi. E. of Wolverine Pt., no. 6839. Along Quatre Fourches R., no. 1201; Ft. Smith, no. 1194; and *Seton & Preble,* no. 78384(O); and *Miss E. Taylor,* no. 15459(O). Great Slave L.: Taltheilei Narrows, no. 1195; Fairchild Pt., nos. 1196, 1198, 1200; Ft. Reliance, no. 1199; N. W. shore, *Bedford* (O); Old Ft. Rae, *Russell* (O). Near southern end of Artillery L., *J. W. Tyrrell,* no. 23113(O); Last Woods, Artillery L., *Seton & Preble,* no. 78383(O).

Vaccinium Oxycoccus L. — *Oxycoccus Oxycoccus* (L.) MacM. — Common on mossy hummocks in wet muskegs northward at least to Great Bear Lake (*J. M. Bell,* O). Preble states that it is especially common at Bear Lake and Fort Norman. Noted by Richardson "to the Arctic sea-shore." — Lake Athabaska: Shelter Pt., no. 1203, near Sand Pt., no. 4514; Charlot Pt., no. 6306. Great Slave L.: *Kennicott* (N); Taltheilei Narrows, no. 1205; N. shore of McLeod Bay, no. 1206; Fairchild Pt., nos. 1204, 1207; S. W. and N. shores, *Howe,* no. 91966 (O); near Ft. Rae, *Russell* (O).

DIAPENSIACEAE

Diapensia lapponica L. — An arctic species known in our region only in the Lockhart basin. — Casba L., *J. W. Tyrrell,* no. 23114(O).

PRIMULACEAE

Primula incana M. E. Jones. — See Rhod. **30:** 59 (1928). — Occasional or common in damp meadows and prairies in the Wood Buffalo Park, but not known east of the Paleozoic boundary. Noted in Fl. Bor.-Am. (under *P. farinosa*) northward "to lat. 66° on the Mackenzie River." — Cascade Rapid, Athabaska R., *Miss E. Taylor,* no. 15828(O); Government Hay Camp district, Slave R., no. 3010; Great Slave L., *Richardson* (G).

Primula mistassinica Michx. — Common on damp sandy or stony shores about Athabaska and Great Slave Lakes, and known northward to Great Bear Lake (*J. M. Bell,* O) and the Mackenzie River (*Richardson,* G, under *P. Hornemanniana* of Fl. Bor.-Am.). — Lake Athabaska: Shelter Pt., nos. 1227, 1228; Sand Pt., nos. 4481, 4631; N. shore, *J. W. Tyrrell,* no. 15840(O); west shore of Ellis Bay, no. 6366. Great Slave L.: Keith Isl., no. 1226; Fairchild Pt., nos. 1224, 1225; S. W. and N. shores, *Howe,* no. 91961(O); Pine Pt., *Brooke* (O).

Primula egaliksensis Wormsk. — See Rhod. **30:** 59 (1928). — Occasional on damp sandy shores in the eastern arm of Great Slave Lake, and known on Great Bear Lake (*J. M. Bell,* O). Richardson noted the range of *P. sibirica,* which appears to be identical with *P. egaliksensis,* as "Barren country between lat. 60° and 69°. — Great Slave L.: Keith Isl., no. 1230; base of Maufelly Pt., no. 1229.

Primula stricta Hornem. — See Rhod. **30:** 59 (1928). — Known in our region only from an indefinite locality on Great Slave Lake, but apparently common or occasional on the Mackenzie River (*Dutilly,* G; *Miss E. Taylor,* O; *Richardson,* G.) — Shore of Great Slave L., *R. Bell,* no. 23158(O).

Androsace septentrionalis L. — See Mem. 126, Biol. Ser. no. 4, Dept. of Mines, Can., 45 (1922). — Occasional in dry meadows, on sandy banks and rocky hills northward to the lower Mackenzie (*Miss E. Taylor,* O), but apparently rare eastward of the Paleozoic boundary. — Portage la Loche, *John Macoun,* no. 15863(O). Lake Athabaska: Chipewyan, nos. 4683, 6058; and *Preble & Carey,* no. 2(W) (N. E.; var. *puberulenta* of St. John's revision); Charlot Pt., no. 6093. East shore of L. Mamawi, no. 3005; Ft. Smith, nos. 1232, 3006; Resolution, *Kennicott* (N). — Extremely variable in form, size and degree of pubescence. The writer has preferred to maintain the forms represented in the Mackenzie basin in one species, although further collections may show well-defined geographical segregates.

Dodecatheon pauciflorum (Durand) Greene. — Abundant in the semi-open prairie country on the Salt Plain west of the Slave River, but not known elsewhere in the Mackenzie basin except for the Kennicott record cited. — Resolution, *Kennicott* (N).

Lysimachia thyrsiflora L. — *Naumbergia thyrsiflora* (L.) Duby. — Occasional on wet banks and shores northward at least to Great Slave Lake. Noted in Fl. Bor.-Am. from "Lake Huron to the Mackenzie River." — Lower Athabaska R., *Kennicott* (N); sandy pond margin about 5 mi. S. E. of Wolverine Pt., L. Athabaska, no. 6827; Old Ft. Rae, Great Slave L., *Russell* (G).

Trientalis borealis Raf. — *T. americana* (Pers.) Pursh. —See Rhod. **11**: 236 (1909). — Common in rich woods northward to the lower Athabaska River and about Lake Athabaska. — Waterways, no. 3002; Calumet, Athabaska R., no. 1223; along lower Firebag R., no. 6037. Lake Athabaska: near Sand Pt., no. 4478; along Archibald R. near its mouth, no. 6760; 5 mi. S. E. of Wolverine Pt., no. 6819. Black R., E. of L. Athabaska, *J. W. Tyrrell,* no. 15925(O).

Trientalis europaea L. var. **arctica** (Fisch.) Ledeb. — *T. arctica* Fisch. — See Bull. 74, Nat. Mus. Can. 156 (1935). — Known in the Mackenzie basin only in the Wood Buffalo Park and southwestward. It grows in rich woods.

Glaux maritima L. — Common at the margins of saline flats and brine springs west of the Slave River, and known northward to the Mackenzie (*Kennicott,* N). — Sulfur Bay, Great Slave L., *Hume,* no. 102677(O).

PLUMBAGINACEAE

Statice interior, sp. nov. PLATE 198[1]

Herba perennis scaposa, e radice sensim ad basin plantae attenuata, 2–3 mm. crassa (ex sicco); folia linearia, dense congesta, foliis multis marcescentibus infra recentes, lamina glabra, 2–6 cm. longa, 2–3.5 mm. lata (plerumque circa 2.5 mm.), obtusa vel leviter apiculata, uno nervo conspicuo et 2 vel 4 nervis obscuris ad basin foliorum majorum; scapi novelli 1–7, plerumque paucis anni praeteriti persistentibus, glabri, plerique circa 1.2 mm. crassi, 10–18 cm. alti; capituli hemisphaerici, circa 2 cm. lati; spiculae pleraeque 2-florae; bracteae fructiferae orbiculari-ovatae, basi cuneatae, margine leviter undulatae, scariosae, basi excepta flavescentes; flores breviter stipitati (1 mm. vel. breviores), circa 7 mm. longi; calyx omnino glaber, arista exclusa circa 6 mm. longus, parte basali virescente circa 3 mm. longa et 1.5 mm. lata, nervis 5 primariis in parte superiore scariosa purpurascentibus, nervis intermediis in parte inferiore primarios aequantibus; calycis nervi primarii in dentes conspicuos aristas simulantes lobis conspicuis rotundatis separatos producti, dentibus 1.3–1.4 mm. ultra basin loborum productis; corolla rosea, lobis rotundatis vix calycem excedentibus.

Occasional in low damp places among the large sand dunes south of William Point, L. Athabaska, Aug. 16, 1935, no. 6895 (Type, G).

This species is distinct from all other North American forms in its broad leaves, its entirely glabrous calyx, and its prominent calyx teeth. Its leaves are nearly twice as broad as those of most American plants,

[1]PLATE 198. *Statice interior* Raup. Part of type collection from dunes south of William Pt., Lake Athabaska, no. 6895; detail of flowers × 5.

and its glabrous calyx would suggest removing it entirely from those sections of the genus represented in this country. Its nearest affinity appears to be *S. labradorica* (Wallr.) Hubbard & Blake, which has short cusps on the main lobes of the calyx. It differs from this species, however, in having the rounded intermediate lobes of the calyx prominently developed, to approximately half the length of the main lobes and cusps, all the lobes being .3–.4 mm. longer than those of *S. labradorica* var. *genuina* Blake which it most nearly resembles.

GENTIANACEAE

Gentiana Amarella L. — *Amarella plebeia* (Cham.) Greene. — Common in damp meadows, muskegs, open woods, and damp rock crevices northward to Great Slave Lake, and known on the lower Mackenzie (*Onion,* N). — McMurray, no. 7086. Lake Athabaska: Chipewyan, no. 7028; near Sand Pt., no. 4627; Fishhook Bay, no. 6591. East shore of L. Mamawi, no. 3037; Gov. Hay Camp district, nos. 3032, 3033; near upper Smith Rapids, no. 1238. Great Slave L.: Fairchild Pt., nos. 1235, 1236; Ft. Reliance, no. 1237; S. W. and N. shores, *Howe,* no. 91959(O); N. W. shore, *Bedford* (O); Ft. Rae, *Russell* (O).

Gentiana elegans A. Nels. — See Bull. 74, Nat. Mus. Can. 157 (1935). — Common or occasional northward to the Mackenzie River (*Jones,* O; *Onion,* N), and abundant on the Salt Plains west of the Slave River. It has not been found east of the Paleozoic boundary. — Government Hay Camp district, Slave R., no. 3027. Great Slave L.: S. W. and N. shores, *Howe,* no. 91958(O); Sulfur Bay, *Hume,* no. 102678(O).

Lomatogonium rotatum (L.) Fries. — *Pleurogyne rotata* (L.) Griseb. — *P. fontana* A. Nels. — See Rhod. **21:** 197 (1919). — Occasional in damp meadows and muskeg thickets in the Wood Buffalo Park and northward to the Mackenzie (*Onion,* N), but not known east of the Paleozoic boundary. — S. W. and N. shores of Great Slave L., *Howe,* no. 91960(O).

Menyanthes trifoliata L. — See Rhod. **31:** 195 (1929). — Common in very wet muskegs northward to Great Slave Lake, and known on the lower Mackenzie (*Kennicott,* N; *Miss E. Taylor,* O). — Lake Athabaska: East end, *J. W. Tyrrell,* no. 59564(O); William Pt., no. 6867; about 3 mi. W. of Ennuyeuse Cr., no. 6961. Great Slave L.: N. shore of McLeod Bay, no. 1234; Fairchild Pt., no. 1233; N. W. shore, *Bedford* (O).

APOCYNACEAE

Apocynum androsaemifolium L. — Noted in Fl. Bor.-Am. as occurring "throughout the woody country," but the northern-most speci-

mens seen by the writer are from Great Slave Lake. — Lake Athabaska: Shelter Pt., no. 1240; dolomitic hills near base of Cornwall Bay, nos. 6434, 6560; Sand hill country about 4 mi. S. E. of Wolverine Pt., no. 6779. Fort Smith (*Mrs. Conibear* coll.), no. 1239; N. W. shore of Great Slave L., *Bedford* (O).

Apocynum sibiricum Jacq. — *A. hypericifolium* Ait. — *A. cannabinum* L. var. *hypericifolium* (Ait.) Gray. — See Rhod. **37:** 327–8 (1935). — Occasional on dry river banks along the lower Athabaska, and along the lower Peace River in the Wood Buffalo Park. — McMurray, no. 7065.

POLEMONIACEAE

Polemonium humile Willd. — Noted in Fl. Bor.-Am. "From lat. 66° to the Arctic sea-coast" (as *P. coeruleum* var. *humile*). The following specimens suggest a more southern range, and are the only ones available for the Mackenzie basin. — "Carlton House to Bear Lake," *Richardson* (G); Great Slave L., *Richardson* (G). — The genus *Polemonium* has been very little collected in the Mackenzie basin, particularly east of the Rocky Mountains. The species are very poorly defined in this region, and are much in need of further collection and study.

Collomia linearis Nutt. — *Gilia linearis* (Nutt.) Gray. — Common or occasional in dry prairies in the Wood Buffalo Park and southwestward. Noted by Harper on the lower Taltson River, and by Richardson "From Saskatchewan to Fort Franklin." A specimen in Herb. G. labeled Mackenzie R. is presumably from the Richardson collection. — East shore of L. Mamawi, no. 3023.

HYDROPHYLLACEAE

Phacelia Franklinii R. Br. — Common in clearings and natural openings about the great lakes and in the Wood Buffalo Park, becoming abundant in burned areas. It is at least occasional northward to Great Bear Lake (*Richardson,* G) (*Eutoca Franklinii* in Fl. Bor.-Am.). — Lake Athabaska: near Sand Pt., no. 4479; N. shore of Ellis Bay, no. 6120; near base of Cornwall Bay, no. 6429; east end, *J. W. Tyrrell,* no. 17009(O). Great Slave L.: Resolution, *Onion, Kennicott & Hardisty* (N); Taltheilei Narrows, no. 1241; Windy Pt., *Hume,* no. 102679(O); Old Ft. Rae, *Russell* (O).

BORAGINACEAE

Lappula Redowskii (Hornem.) Greene var. **occidentalis** (Wats.) Rydb. — Occasional to common about settlements, and inland in the Wood Buffalo Park. The note in Fl. Bor.-Am., "Cumberland House to Bear Lake," under *Echinospermum patulum,* and the same in Macoun's

Cat. under *E. Redowskii* var. *occidentale*, probably refer to this species. — Chipewyan, nos. 6063, 6066, Ft. Smith, *Seton & Preble*, no. 78385(O).

Hackelia deflexa (Wahl.) Opiz. var. **americana** (Gray) Fern. & Johnston. — *Lappula americana* (Gray) Rydb. — *Hackelia deflexa* (Wahl.) Opiz of Am. auth. — See Rhod. **26**: 124 (1924). — Known in the Mackenzie basin from a single collection in a cabin clearing along the Upper Slave River. — 30th base line district, Slave River, no. 3200.

Mertensia paniculata (Ait.) Don. — See Contr. Gray Herb. n. ser. **48**: 1–20 (1916). — Common in open woods, prairies and cabin clearings northward to Great Slave Lake, and known on the Mackenzie (*Onion*, N). It has not been found east of the Paleozoic boundary. — Waterways, no. 3206; Calumet, Athabaska R., no. 1243; along lower Firebag R., no. 6033-a; along the Quatre Fourches R., no. 1244; Gov. Hay Camp, Slave R., nos. 3208, 3209; Hay R., Great Slave L., *Hume*, no. 102680(O).

LABIATAE

Scutellaria epilobiifolia Hamilton. — *S. galericulata* Amer. auth., not L. — See Rhod. **23**: 86 (1921). — Common in wet meadows northward to the Wood Buffalo Park, and at least occasional to the Mackenzie (*Onion*, N; *Ross*, N; *Kennicott*, N), but not known very far east of the Paleozoic boundary. — Shelter Pt., L. Athabaska, nos. 1250, 1251; E. shore of L. Mamawi, no. 3186; Upper Slave R. lowland, nos. 3190, 3191; S. W. and N. shores of Great Slave L., *Howe*, no. 91955 (O).

Dracocephalum parviflorum Nutt. — *Moldavica parviflora* (Nutt.) Britton. — Common in dry openings and clearings northward at least to the Wood Buffalo Park, and known on the Mackenzie (*Onion*, N). It is abundant as a "fireweed" in new burns, and appears to be rare or occasional east of the Paleozoic boundary. — Near base of Cornwall Bay, L. Athabaska, no. 6430; Resolution, *Kennicott* (N); "Between Bear Lake and Cumberland House," *Richardson* (G).

Agastache Foeniculum (Pursh) Ktze. — *Lophanthus anisatus* Benth. — Noted in Fl. Bor.-Am. north "to Fort Franklin on the Mackenzie River," and in Macoun's Cat. "north to Lake Athabaska." It is apparently rare northward and the writer has seen only the following material. — McMurray (growing as a roadside weed), nos. 7081, 7116; Resolution, *Kennicott* (N).

Physostegia parviflora Nutt. — *Dracocephalum Nuttallii* Britton. — Known thus far in the Mackenzie basin only in the delta low-

lands west of Lake Athabaska and along the Upper Slave River, where it is rather common at willow slough margins and on low mud flats. — East shore of L. Mamawi, nos. 3183, 4401; Murdock Cr. district, no. 3184; Gov. Hay Camp district, Slave R., no. 3185.

GALEOPSIS TETRAHIT L. — Introduced in the southern districts, where it grows in waste places. — Waterways, no. 3198.

Stachys scopulorum Greene. — Common in prairies and at the drier margins of sloughs northward to the Wood Buffalo Park, and at least occasional on the Mackenzie (*Onion, Kennicott & Hardisty*, N) (N. E.). Not known far eastward of the Paleozoic boundary. Noted in Fl. Bor.-Am. as extending to Ft. Franklin, and by Harper at Tsu Lake, both under *S. palustris*. — McMurray, no. 7054; lower delta of Athabaska R., no. 1248; Shelter Pt., L. Athabaska, no. 1249; E. shore of L. Mamawi, nos. 3170, 4397; Upper Slave R. lowland, nos. 3178, 3180, 3181; Resolution, *Onion, Kennicott & Hardisty* (N) (N. E.).

Monarda mollis L. var. **menthaefolia** Fern. — See Rhod. **3**: 15 (1901). — Common or occasional in dry prairies in the Wood Buffalo Park and southwestward.

Lycopus uniflorus Michx. — Known in the Mackenzie basin only on the south side of Lake Athabaska, where it is abundant at the margins of sandy ponds. — Ponds about 5 mi. S. E. of Wolverine Pt., nos. 6822, 6825; 2 mi. W. of Ennuyeuse Creek, nos. 6978, 6984.

Mentha canadensis L. var. **glabrata** Benth. — *M. arvensis* L. var. *glabrata* (Benth.) Fern. — Common in sloughs, wet meadows, and on stream margins northward to the Mackenzie (*Onion*, N; *Miss E. Taylor*, O), but not extending far eastward from the Paleozoic boundary. Plants noted in the Tazin basin by Harper under *M. glabrior* probably belong here. — McMurray, no. 7061; lower delta of Athabaska R., no. 1247; Shelter Pt., L. Athabaska, nos. 1245, 1246; E. shore of L. Mamawi, nos. 3168, 4399; upper Slave R. lowland, nos. 3163, 3164; N. W. shore of Great Slave L., *Bedford* (O).

SCROPHULARIACEAE

Limosella aquatica L. — Noted by John Macoun "on mud flats on the Lower Peace River and at Fort Chipewyan," but unknown elsewhere in the Mackenzie basin except for the following. — Damp sand at margin of beach lagoon, Sand Pt., L. Athabaska, no. 4569.

Veronica americana Schwein. — Noted in Macoun's Cat., "northward to Lake Athabaska," but the writer has seen no material from beyond the lower Athabaska River. Occasional in wet meadows and on wet river banks in the southwestern part of the Mackenzie basin. — Calumet, Athabaska R., no. 1255.

Veronica scutellata L. — Occasional or common in wet sloughs northward at least to Great Slave Lake, but not known far east of the Paleozoic boundary. — Government Hay Camp district, Slave R., no. 3148; near Ft. Smith, no. 1252; N. W. shore of Great Slave L., *Bedford* (O).

Veronica peregrina L. var. **xalapensis** (HBK.) Pennell. — *V. xalapensis* HBK. — See Torreya, **19**: 167 (1919). — Occasional or common on damp shores, in rock crevices, wet meadows and open prairies northward at least to the western part of Lake Athabaska, and to the Wood Buffalo Park. Noted in Fl. Bor.-Am. (under *V. peregrina*) "Throughout Canada to the Mackenzie River." — Lake Athabaska: Chipewyan, no. 4700; Shelter Pt., nos. 1253, 1254. East shore of L. Mamawi, no. 3146.

Euphrasia subarctica Raup. — See Rhod. **36**: 87–8 (1934). — Occasional in damp mossy crevices and muskegs about the north side of Lake Athabaska, and known at the eastern end of Great Slave Lake. The record for *E. officinalis* in Fl. Bor.-Am., "Canada and Newfoundland, to lat. 64° N," probably includes this species in the northwest. — Lake Athabaska: near Sand Pt., no. 4633 (Type); base of Cornwall Bay, no. 6612; Clut L., near E. end of L. Athabaska, *Campbell*, no. 132401(O). Fairchild Pt., Great Slave L., no. 1266.

Castilleja Raupii Pennell. — *C. pallida* of most auth. — See Proc. Acad. Nat. Sci. Phila. **86**: 528–31 (1934). — Occasional to common in upland woods, the willow margins of wet meadows and streams, and on sandy lake shores. — Calumet, Athabaska R., no. 1260. Lake Athabaska: Sand Pt., no. 4562; N. E. shore of Ellis Bay, no. 6126; near mouth of Charlot R., nos. 6318, 6351; W. shore of Ellis Bay, no. 6371. 30th base line district, Slave R., no. 1258; Ft. Smith, no. 1261; and *Seton & Preble*, no. 78386(O) (*C. pallida* var. *septentrionalis* of Seton's list); Lower Slave R., no. 1262. Great Slave L.: Caribou Isl., *Seton & Preble*, no. 78387(O) (*C. pallida* var. *septentrionalis* of Seton's list); Keith Isl. and vicinity, nos. 1257, 1264; Taltheilei Narrows, no. 1263; Maufelly Pt., no. 1265; Fairchild Pt., no. 1259; S. W. and N. shores, *Howe*, no. 91957(O); Windy Pt., *Hume*, no. 102682(O); Pine Pt., *Brook* (O); near Ft. Rae, *Russell* (O); Hay R., *Preble & Carey*, no. 16 (W) (N. E.).

Orthocarpus luteus Nutt. — Known in our region only in dry prairies at Peace Point, in the Wood Buffalo Park.

Rhinanthus Kyrollae Chab. — Occasional on the north shore of Lake Athabaska and in the Wood Buffalo Park, growing in damp thickets. Richardson noted *R. Crista Galli* "to the shores of the Slave Lake,

and to Fort Franklin," and Harper has a record for *R. oblongifolius* at the "Mouth of Taltson River," but whether these are all referable to the above is uncertain. The group is poorly understood and badly in need of further material and study. — Lake Athabaska: Shelter Pt., no. 1267; Fishhook Bay, no. 6584 ?.

Pedicularis labradorica Houttuyn. — See Rhod. **33:** 193 (1931). — Occasional to common in woods, muskegs and rock crevices about Great Slave Lake, but apparently rare in the Wood Buffalo Park and on Lake Athabaska. Known on Great Bear Lake (*J. M. Bell,* O) and the lower Mackenzie (*Miss E. Taylor,* O). — Great Slave L.: Taltheilei Narrows, no. 1271; Maufelly Pt., no. 1269; Fairchild Pt., nos. 1270, 1272, 1273, 1274; Ft. Reliance, no. 1268; Windy Pt., *Hume,* no. 102681(O); N. W. shore, *Bedford* (O); Ft. Rae, *Russell* (O). Artillery L., *Seton & Preble,* no. 78579(O).

Pedicularis lanata Cham. & Schlecht. — An arctic and alpine species known in our region only in the Lockhart basin. — Artillery L., *J. W. Tyrrell,* no. 23119(O) (*P. Langsdorfii* var. *lanata* of Tyrrell's list).

Pedicularis lapponica L. — Known in our region only on the northeastern height of land. — Portage between Clinton-Colden L. and the Thelon R., *J. W. Tyrrell,* no. 23117(O) (*P. euphrasioides* in Tyrrell's list).

Pedicularis parviflora Smith. — Known in the Mackenzie basin from a single locality near the south shore of Lake Athabaska. — Margin of wet muskeg about 3 mi. W. of Ennuyeuse Creek, nos. 6965, 6968.

Melampyrum lineare Lam. — Common in dry sandy woods about Lake Athabaska, and probably common in similar situations southward. — Vicinity of Athabaska Landing, *Brinkman,* no. 4063(N). Lake Athabaska: Shelter Pt., nos. 1276, 4465; 5 mi. E. of Poplar Pt., nos. 6688, 6700; 2 mi. W. of Ennuyeuse Cr., no. 6937.

OROBANCHACEAE

Boschniakia rossica (Cham. & Schl.) Hulten. — See Kgl. Sv. Akad. Handl. Ser. 3, 8. No. **2:** 126 (1930). — Occasional to common about Great Slave Lake, in mossy woods. The Fairchild Point specimens come from clumps of *Alnus viridis.* Known also on the lower Mackenzie (*Dutilly,* G; *Miss E. Taylor,* O), and noted by Richardson at Ft. Franklin. — Great Slave L.: *R. Bell,* no. 23149(O); Fairchild Pt., nos. 1277, 1278, 1279.

LENTIBULARIACEAE

Pinguicula vulgaris L. — Common about Great Slave Lake, and known at Great Bear Lake (*J. M. Bell,* O) and on the lower Mac-

kenzie (*Miss E. Taylor*, G, O). It grows in damp mossy crevices. — Great Slave L.: *Richardson* (G); Keith Isl., no. 1282; Taltheilei Narrows, no. 1281; base of Maufelly Pt., no. 1280; S. W. and N. shores, *Howe*, no. 91956(O); N. W. shore, *Bedford* (O); Ft. Rae, *Russell* (O).

Pinguicula villosa L. — An arctic and alpine species known in our region about the eastern arm of Great Slave Lake and on the north side of Lake Athabaska. It grows on mossy hummocks in muskegs. — Charlot Pt., L. Athabaska, no. 6307. Great Slave L.: Caribou Isl., *Seton & Preble*, no. 78292(O); Taltheilei Narrows, no. 1285; N. shore of McLeod Bay, near Hoarfrost R., no. 1283; Fairchild Pt., nos. 1284, 1286.

Utricularia vulgaris L. — Common to abundant in shallow lakes and sluggish streams northward at least to Great Slave Lake. — Cree (Mamawi) Cr., Athabaska delta, no. 3139. Lake Athabaska: pond near base of Cornwall Bay, no. 6624; 2 mi. W. of Ennuyeuse Cr., no. 7004. Grande Detour Portage, lower Slave R., Russell, no. 74(G). Great Slave L.: Yellowknife Bay, no. 1291; N. W. shore, *Bedford* (O); Ft. Rae, *Russell* (O).

Utricularia minor L. — Probably common at shallow lake margins northward at least to Great Slave Lake, though not extensively collected. — Lake Athabaska: William Pt., no. 6860; 2 mi. W. of Ennuyeuse Cr., no. 7003. Great Slave L.: Fairchild Pt., no. 1292.

Utricularia intermedia Hayne. — Occasional or common at shallow pond margins about Athabaska and Great Slave Lakes. Noted in Fl. Bor.-Am. from Lake Huron "to Bear Lake," and by Harper in a "muskeg pond near Athabaska River, 10 miles below McMurray." — Lake Athabaska: Charlot R., near its mouth, no. 6365; 5 mi. S. E. of Wolverine Pt., no. 6826; William Pt., nos. 6858, 6859. Great Slave L.: Fairchild Pt., nos. 1288, 1290; Bell Isl., Charlton Bay, no. 1289; Yellowknife Bay, no. 1287.

PLANTAGINACEAE

Plantago major L. var. **asiatica** Decaisne. — Common on river banks and in damp meadows northward at least to the Wood Buffalo Park, but not extending far east from the Paleozoic boundary. Noted in Fl. Bor.-Am. (as *P. major*) from "Lake Huron . . . to lat. 68." — McMurray, no. 7064; Calumet, Athabaska R., no. 1296; Reed Portage, upper Athabaska delta, no. 3132; Shelter Pt., L. Athabaska, nos. 1293, 4435; Upper Slave R. lowland, nos. 1295, 3134, 3135; Ft. Smith, no. 1294.

Plantago eriopoda Torr. — Common on saline flats in the Wood

Buffalo Park and southwestward. The record in Macoun's Cat., "northward to the Arctic Sea" probably refers in part to *P. septata* Morris, a species of the lower Mackenzie.

Plantago oliganthos R. & S. — See Rhod. **27**: 93 (1925). — Known in the Mackenzie basin only on salt flats west of the Upper Slave River.

RUBIACEAE

Galium boreale L. — Common to abundant in dry open woods, prairies and clearings northward to the Mackenzie (*Miss E. Taylor*, O; *Onion, Kennicott & Hardisty*, N), but very little known east of the Paleozoic boundary. Harper noted it on the Taltson River at Twin Gorges and below Tethul R., and on the Athabaska River at Pelican Portage, but no specimens are available. — Calumet, Athabaska R., no. 1305; Shelter Pt., L. Athabaska, no. 1306; E. shore of L. Mamawi, no. 3112; along Quatre Fourches R., no. 1303; upper Slave R. lowland, nos. 1302, 3107, 3108; Ft. Smith, no. 1304. Great Slave L.: Sulfur Bay, *Hume*, no. 102685(O); N. W. shore, *Bedford* (O); Old Fort Rae, *Russell* (O).

Galium trifidum L. — Common in sloughs and damp meadows northward at least to Lake Athabaska and the Wood Buffalo Park. Richardson's record for *G. Claytoni*, "as far north as lat. 68°" probably refers to this species. — Lake Athabaska: Shelter Pt., nos. 1297, 1298, 1299; bank of Charlot R. near its mouth, no. 6363; near base of Cornwall Bay, no. 6492; 5 mi. E. of Poplar Pt., no. 6702. Upper Slave R. lowland, nos. 3122, 3126, 3128; Ft. Smith, no. 1304.

Galium triflorum Michx. — Common in damp woods in the lowlands about the western end of Lake Athabaska and southward. — McMurray, no. 7047; and *Dutilly*, no. 111(G); Reed Portage, upper Athabaska delta, no. 3098; Chipewyan, no. 4685; along Quatre Fourches R., no. 1301.

CAPRIFOLIACEAE

Viburnum pauciflorum Raf. — Abundant in open woods northward at least to Great Slave Lake, and known at Great Bear Lake (*J. M. Bell*, O) and on the Mackenzie (*Onion, Kennicott & Hardisty*, N). Back's record for *V. acerifolium*, "Slave River, and Athabaska," probably belongs here, as do also the Mackenzie basin records in Fl. Bor.-Am. for *V. edule* and *V. Oxycoccus*. — McMurray, no. 7111; Calumet, Athabaska R., no. 1330; along lower Firebag R., no. 6018. Lake Athabaska: N. shore, *J. W. Tyrrell*, no. 9548(O); Shelter Pt., nos. 1325, 1329; Charlot Pt., no. 6143; Cornwall Bay, no. 6596; along Archibald R. near its mouth, no. 6757. East shore of L. Mamawi, no. 3084; along

Quatre Fourches R., no. 1327; upper Slave R. lowland, nos. 1322, 3081; Ft. Smith, no. 1324; and *Seton & Preble*, no. 78333(O). Great Slave L.: Resolution, *Kennicott* (N); Taltheilei Narrows, no. 1323; Fairchild Pt., no. 1328; N. W. shore, *Bedford* (O).

Symphoricarpos occidentalis Hook. — Richardson noted this species between latitudes 54° and 64°, but the writer has seen no material from beyond the south shore of Great Slave Lake. It grows in dry prairies and is abundant in parts of the Wood Buffalo Park. It has not been found far east of the Paleozoic boundary. — McMurray, no. 7093; Chipewyan, *Dutilly*, no. 133(G); E. shore of L. Mamawi, no. 3061; Gov. Hay Camp district, Slave R., no. 3064; Resolution, *Kennicott* (N).

Symphoricarpos albus (L.) Blake var. **pauciflorus** (Robbins) Blake. — *S. pauciflorus* (Robbins) Britton. — *S. racemosus* Michx. var. *pauciflorus* Robbins. — See Rhod. **16**: 119 (1914). — Common to abundant in open, chiefly aspen woods, northward to Lake Athabaska and the Wood Buffalo Park. Most frequent in the Paleozoic or younger regions. — Lac la Biche, no. 6006; McMurray, no. 7103. Lake Athabaska: Chipewyan, no. 7031; near Sand Pt., no. 4670; Charlot Pt., no. 6135. East shore of L. Mamawi, nos. 3075, 3076, 4417; Gov. Hay Camp, Slave R., no. 3072; Ft. Smith, no. 1320.

Linnæa borealis L. var. **americana** (Forbes) Rehder. — *L. americana* Forbes. — Common in rich woods throughout our region, and northward to Great Bear Lake (*J. M. Bell*, O) and the lower Mackenzie (*Miss E. Taylor*, G). Noted by Seton on Aylmer Lake, in the Barren grounds. — Calumet, Athabaska R., nos. 1312, 1314. Lake Athabaska: Shelter Pt., nos. 1313, 1315; Charlot Pt., no. 6275. Along the Quatre Fourches R., no. 1307; Gov. Hay Camp district, Slave R., no. 3053; Ft. Smith, no. 1311; and *Miss E. Taylor*, no. 9572(O); Cascade Portage, Slave R., *Onion, Kennicott & Hardisty* (N). Great Slave L.: near Caribou Isl., *Seton & Preble*, no. 78335(O); Taltheilei Narrows, no. 1316; base of Maufelly Pt., no. 1309; Fairchild Pt., nos. 1308, 1310; Yellowknife Bay, no. 1317; Windy Pt., *Hume*, no. 102684(O); S. W. and N. shores, *Howe*, no. 91954(O); N. W. shore, *Bedford* (O); Old Fort Rae, *Russell* (O).

Lonicera glaucescens Rydb. — Common in open upland woods northward in the Paleozoic or younger country to the Wood Buffalo Park, and occasional on Lake Athabaska. — McMurray, *Dutilly*, no. 113(G); Calumet, Athabaska R., no. 1319; Lake Athabaska: Charlot Pt., no. 6292; near base of Cornwall Bay, no. 6504. East shore of L. Mamawi, no. 3088; Ft. Smith, no. 1318; and *Miss E. Taylor*, no. 9658(O); and *Seton & Preble*, no. 78334(O).

Lonicera involucrata (Richards.) Banks. — *Distegia involucrata* (Richards.) Cockerell. — Richardson noted this species between lat. 54° and 64°, but the northernmost specimens seen by the writer are from Lac la Biche. Preble noted it "on the banks of the Athabaska," but no farther northward. — Lac la Biche, nos. 3097, 6008; "Rocky woods, between lat. 54°–64°," *Richardson* (O).

ADOXACEAE

Adoxa Moschatellina L. — Definitely known in our region only in the extreme southern part, along the Athabaska River. Noted by Richardson, however, in the "wooded country, lat. 54°–64°." — Athabaska R., near Cascade Rapids, *Miss E. Taylor* (G, N, O); Athabaska R., lat. 56°, *J. M. Macoun,* no. 9484(O).

VALERIANACEAE

Valeriana septentrionalis Rydb. — *V. sylvatica Banks.* — Occasional in upland muskeg thickets in the Wood Buffalo Park. Noted by Richardson on the Clearwater River near Methye Portage, but otherwise unknown in our region.

CAMPANULACEAE

Campanula rotundifolia L. — Common in open woods, dry prairies, and rocky hills northward at least to the western part of Great Slave Lake. Noted in Fl. Bor.-Am., under *C. linifolia,* as far north as lat. 64°. Mackenzie basin material recorded under *C. petiolata* in Fl. Bor.-Am. is included here. — Calumet, Athabaska R., no. 1332. Lake Athabaska: Shelter Pt., nos. 1334, 1335, 1336, 4425; Sand Pt., nos. 4485, 4536; Charlot Pt., nos. 6290, 6404; island near base of Charlot Pt., no. 6390; Cornwall Bay, no. 6454; hills S. of Wabba L., no. 6474; near Archibald R., S. of Wolverine Pt., no. 6743. East shore of L. Mamawi, no. 3048; along the Quatre Fourches R., no. 1331; Gov. Hay Camp district, Slave R., no. 3045. Great Slave L.: S. W. and N. shores, *Howe,* no. 91953(O); Windy Pt., *Hume,* no. 102683(O); N. W. shore, *Bedford* (O); Ft. Rae, *Russell* (O).

LOBELIACEAE

Lobelia Kalmii L. — Apparently rare in the Mackenzie basin, and known only from the following records. Noted by Richardson in saline marshes in lat. 60°. — Sandy muskeg, N. arm of Great Slave L., *Hume,* no. 102686(O).

COMPOSITAE

Grindelia perennis A. Nels. — *G. squarrosa* (Pursh) Dunal ex Torr. & Gray. — See Ann. Mo. Bot. Gard. **21:** 485–8 (1934). — Com-

mon on the Salt Plain prairies west of the Slave River, but not known elsewhere in our region. Noted in Fl. Bor.-Am., under *Donia squarrosa* Pursh, in the "woody country between lat. 54°–64°," but the writer has seen no material from beyond the Wood Buffalo Park.

Solidago multiradiata Ait. — An arctic and alpine species the typical form of which is known in our region only on Great Slave Lake where it grows on rocky hills or on sandy or stony plains and beaches. At least a part of the material referred to under *S. Virgaurea,* "woody country between lat. 54° and 64°," in Fl. Bor.-Am. probably belongs here. — Great Slave L.: Taltheilei Narrows, no. 1365; Fairchild Pt., nos. 1362, 1363, 1364; Ft. Reliance, no. 1366; N. W. shore, *Bedford* (O).

Solidago multiradiata Ait. var. **scopulorum** Gray. — Common in clearings and in damp woods and thickets in the Wood Buffalo Park, but not known east of the Paleozoic boundary nor north of Resolution. — Lower Athabaska R., *Kennicott* (N); Government Hay Camp district, Slave R., nos. 3265, 3266; Resolution, *Onion, Kennicott & Hardisty* (N).

Solidago decumbens Greene var. **oreophila** (Rydb.) Fern. — *S. oreophila* Rydb. — See Rhod. **38:** 202–4 (1936). — Common in dry prairies, clearings, and on sandy or rocky shores and upland woods northward to Lake Athabaska and the Wood Buffalo Park. It is known also on the south shore of Great Slave Lake and on the Lower Mackenzie (*Miss E. Taylor,* O). Material noted in Fl. Bor.-Am. under *S. stricta,* and in Macoun's Cat. under *S. humilis,* "Woody country between lat. 54° and 64°," probably belongs here. — Calumet, Athabaska R., no. 1370. Lake Athabaska: Chipewyan, no. 7024; Shelter Pt., nos. 1368, 1369, 4467; Sand Pt., nos. 4491, 4578, 4599, 4640; rocky point at N. W. entrance to Black Bay, no. 6413; Cornwall Bay, no. 6533; 2 mi. E. of Wolverine Pt., no. 6710; 4 mi. S. E. of Wolverine Pt., no. 6792. Government Hay Camp district, upper Slave R., no. 3255; Ft. Smith, no. 1367 (*Mrs. Conibear* coll.); Resolution, *Onion, Kennicott & Hardisty* (N).

Solidago nemoralis Ait. var. **decemflora** (DC.) Fern. — See Rhod. **38:** 224–7 (1936). — Known in the Mackenzie basin from two collections on Lake Athabaska, where it inhabits dry rocky and sandy uplands. — Near Archibald R., S. of Wolverine Pt., no. 6744; Chipewyan, no. 7023.

Solidago lepida DC. var. **elongata** (Nutt.) Fern. — *S. elongata* Nutt. — *S. canadensis* of auth., in part. — See Rhod. **17:** 8–10 (1915). — Common in clearings, open woods, and prairies northward

at least to the Wood Buffalo Park, and known on the upper Mackenzie (*Miss E. Taylor,* O), but apparently extending only a short distance east of the Paleozoic boundary. Records in Fl. Bor.-Am. and Macoun's Cat. under *S. canadensis, S. elongata,* and *S. procera,* with notations, "from Slave Lake to Fort Franklin," and "wooded country between lat. 54° and 64°," probably belong here for the most part. — McMurray, nos. 7051, 7066; Calumet, Athabaska R., no. 1359. Lake Athabaska: Chipewyan, no. 7042; Shelter Pt., nos. 1358, 1360, 1361; Sand Pt., no. 4639. East shore of L. Mamawi, no. 3275; Great Slave L., *Richardson* (G).

Solidago lepida DC. var. **fallax** Fern. — See Rhod. **17:** 8–10 (1915). — Apparently occasional in the river lowlands where it inhabits damp meadows. — East shore of L. Mamawi, no. 4402; Gov. Hay Camp district, Slave R., nos. 3280, 3282; lower Slave R., no. 1357; Resolution, *Kennicott* (N).

Solidago graminifolia (L.) Salisb. var. **camporum** (Greene) Fern. — *Euthamia camporum* Greene. — See Rhod. **17:** 12 (1915). — Occasional on damp sandy or muddy shores northward to Lake Athabaska. Records in Fl. Bor.-Am. and Macoun's Cat., "north to lat. 64°," under *S. lanceolata* probably belong here, but the writer has seen no material from so far north. — McMurray, no. 7071. Lake Athabaska: Shelter Pt., nos. 1355, 1356; Sand Pt., nos. 4475, 4547; 5 mi. S. E. of Wolverine Pt., no. 6816. Hay (Prairie) R., no. 3263.

Aster Richardsonii Spreng. — See Contr. Arnold Arb. **6:** 202–4 (1934). — Common on sandy and stony shores about Great Slave Lake, but otherwise not definitely known in our region. It is common northward to the Arctic, and on the upper Peace River, particularly in the Rocky Mountains. Harper noted it at the Grand Rapids of the Athabaska, but no specimen is available. — Great Slave L.: *R. Bell,* no. 23159(O); Caribou Isl., *Seton & Preble,* no. 78336(O) (*A. sibiricus* of Seton's list); Keith Isl., no. 1350; Yellowknife, *Russell* (O); Ft. Rae, *Russell* (O); S. W. and N. shores, *Howe,* no. 91990; N. W. shore, *Bedford* (O).

Aster conspicuus Lindl. — Common in upland woods in the McMurray district and in the southwestern parts of the Wood Buffalo Park. — McMurray, no. 7088.

Aster modestus Lindl. — Known in this region only in the upper Athabaska delta. — Reed Portage, no. 3213.

Aster Lindleyanus T. & G. — Common in open woods and clearings northward to Lake Athabaska and the Wood Buffalo Park, and known on Great Slave Lake; but apparently occasional in the pre-

Cambrian regions. Records in Fl. Bor.-Am. under *A. paniculatus*, "Slave Lake," and under *A. praecox*, "Fort Franklin," are probably referable to this species or some form of it. — McMurray, no. 7087; Reed Portage, Athabaska delta, no. 3239. Lake Athabaska: Chipewyan, nos. 4674, 7025, 7026; Cornwall Bay, nos. 6518, 6608-a. Government Hay Camp district, Slave R., nos. 3245, 3246, 3248, 3249; near upper Smith Rapids, no. 1354; Ft. Smith (*Mrs. Conibear*, coll.) no. 1353; Resolution, *Kennicott* (N); Great Slave L., *Howe*, no. 91065(O).

Aster Lindleyanus T. & G. var. **comatus** Fern. — Apparently rare or occasional, and possibly not worthy of varietal rank. It has been found along the Peace River in the Wood Buffalo Park, and on the Mackenzie River (*Kennicott*, N).

Aster Lindleyanus T. & G. var. **ciliolatus** (Lindl.) Gray. — Known in this region only from Great Slave Lake specimens cited in Fl. Bor.-Am. under *A. ciliolatus*. — Great Slave L.: *Richardson* (G).

Aster laevis L. var. **Geyeri** Gray. — Known only in the southern and southwestern parts of the Mackenzie basin where it inhabits dry prairies and upland woods, and extends northward to the Wood Buffalo Park. — McMurray, no. 7080; Chipewyan, no. 4674-a; E. shore of L. Mamawi, no. 4396.

Aster ericoides L. — *A. multiflorus* Ait. — See Rhod. **28**: 65 (1926), and **32**: 136–40 (1930). — A species of dry prairies and bluffs, known in our region only in the Wood Buffalo Park where it is rather common. — Government Hay Camp district, Slave R., no. 3227.

Aster junceus Ait. — Common to abundant on stream banks and in damp meadows northward at least to the Wood Buffalo Park, and known on Great Slave Lake and the Mackenzie (*Kennicott*, N). It is apparently rare east of the Paleozoic boundary. Records made by Harper under *S. salicifolius* on the Athabaska River and near Salt River probably belong here. Rydberg set up a new species, *A. Franklinianus* (in Bull. Torrey Bot. Club, **37**: 141, 1910), to include the Mackenzie basin specimens of this complex to which he had access (those of Richardson and Kennicott). With more abundant material, however, the writer has been unwilling to separate them, for the present at least, from the wide-ranging *A. junceus*. — McMurray, nos. 1352, 7067, 7070; Sand Pt., L. Athabaska, no. 4545; E. shore of L. Mamawi, nos. 3217, 3218, 3219, 4409; upper Slave R. lowland, nos. 3220, 3221, 3223; near upper Smith Rapids, no. 1351; Resolution, *Onion, Kennicott & Hardisty* (N); Great Slave L., *Richardson* (G, N) (*A. laxifolius* of Fl. Bor.-Am.); Ft. Rae, Russell (O).

Aster puniceus L. — Common in clearings and wet meadows in the great river lowlands, but not known elsewhere in the Mackenzie basin except possibly in the southwestern sections. — Reed Portage, upper Athabaska delta, no. 3214; Murdock Cr. district, no. 3215; Gov. Hay Camp, no. 3216.

Aster paucifiorus Nutt. — Known in the Mackenzie basin only on the Salt Plain prairies west of the upper Slave River.

Aster falcatus Lindl. — Apparently rare in the Mackenzie basin, growing on dry banks and rocky hills. Material noted in Fl. Bor.-Am. under *A. ramulosus,* "Saskatchewan to Fort Franklin on the Mackenzie River," probably belongs here at least in part. The species is very poorly represented in American herbaria, and is greatly in need of further study. It was collected on the Mackenzie by *Onion and Ross* (N). — McMurray, no. 7069; Chipewyan, no. 4684.

Erigeron acris L. var. **asteroides** (Andrz.) DC. — *E. droebachensis* O. Muell. — See Rhod. **12:** 225 (1910). — Common in clearings, damp meadows, and on stream margins northward at least to Lake Athabaska and the Wood Buffalo Park. Noted in Fl. Bor.-Am., under *E. glabratus,* "from the Saskatchewan to Fort Franklin . . .," but the writer has seen no material from beyond Great Slave Lake. — Reed Portage, upper Athabaska delta, no. 3300. Lake Athabaska: Shelter Pt., no. 1346; hill S. of Wabba L., no. 6475; hill country N. E. of Cornwall Bay, no. 6532; mouth of Archibald R., no. 6773. Government Hay Camp, Slave R., nos. 3296, 3297; near upper Smith Rapids, no. 1345; N. W. shore of Great Slave L., *Bedford* (O).

Erigeron acris L. var. **arcuans** Fern. — See Rhod. **28:** 236 (1926). — Common or occasional in muskegs and at wet slough margins throughout the region and far northward on the Mackenzie (*Onion,* N; *Miss E. Taylor,* O). — Lake Athabaska: mouth of Charlot R., no. 6340; muskeg N. of Cornwall Bay, no. 6531. Fort Smith, *Miss E. Taylor* (N); Fairchild Pt., Great Slave L., nos. 1337, 1338, 1339.

Erigeron acris L. var. **debilis** Gray. — See Rhod. **12:** 225 (1910). — Apparently rare in the Mackenzie basin, and known from a single locality on Great Slave Lake. — Muskegs, Fairchild Pt., nos. 1347, 1348.

Erigeron lonchophyllus Hook. — Apparently rare or occasional in semi-open prairies and clearings in the Wood Buffalo Park and southwestward.

Erigeron compositus Pursh var. **trifidus** (Hook.) Gray. — See Contr. Gray Herb. **49:** 72–9 (1917); Univ. Wyo. Pub. Bot. **1:** 172–86 (1926); Rhod. **30:** 122–3 (1928). — An arctic and alpine species,

known in our region only at the eastern end of Great Slave Lake, where it grows on shingle beaches. — Fairchild Pt., Great Slave L., no. 1340.

Erigeron glabellus Nutt. — Common on dry prairies in the Wood Buffalo Park and southwestward, and at least occasional far northward in the Mackenzie country (*Miss E. Taylor,* O; *?Kennicott,* N). Mackenzie basin records under *E. pulchellus* in Fl. Bor.-Am., "Woody country, from Canada to lat. 64°" probably belong here. — Resolution, *Kennicott* (N).

Erigeron philadelphicus L. — Common in damp meadows and on river flood plains northward in the Paleozoic or younger country to the Wood Buffalo Park, and known on the Mackenzie (*Miss E. Taylor,* G; *Kennicott,* N). Notes in Fl. Bor.-Am. under *E. philadelphicus* and *E. purpureus,* "Woody country between lat. 54° and 64°," and "From Lake Huron . . . to the Arctic Circle," are referable here for the most part. — Calumet, Athabaska R., nos. 1341, 1343; E. shore of L. Mamawi, no. 3308; upper Slave R. lowland, nos. 1342, 3311; lower Slave R., no. 1344; "Athabasca and north," *Richardson,* no. 11177(O).

Erigeron canadensis L. — *Leptilon canadense* (L.) Britton. — Apparently rare or occasional in the Mackenzie basin, and known thus far only on granite hills about the western end of Lake Athabaska. — Chipewyan, no. 7039; E. shore of L. Mamawi, no. 3307.

Erigeron hyssopifolius Michx. — Occasional in damp thickets in the Wood Buffalo Park, and northward to Great Bear Lake (*J. M. Bell,* O) and the Mackenzie (*Onion & Ross,* N). Unknown east of the Paleozoic boundary. Richardson's record for *Galatella graminifolia* at Great Slave Lake should be referred here. — 30th base line district, Slave R., no. 1349; Smith Portage, *Miss E. Taylor,* no. 11157(O). Great Slave L.: Pine Pt., *Brooke* (O); Windy Pt., *Hume,* no. 102687 (O); N. W. shore, *Bedford* (O).

Erigeron ramosus (Walt.) B. S. P. — Known in our region only along the upper Slave River and at the western end of Lake Athabaska, where it grows in waste places and on damp muddy shores. — Chipewyan, no. 7041; Gov. Hay Camp district, Slave R., no. 3306.

Antennaria pulcherrima (Hook.) Greene. — Known in our region only from an upland meadow in the Wood Buffalo Park.

Antennaria rosea (D. C. Eat.) Greene. — Common in dry upland woods and prairies northward at least to Great Slave Lake, and known on the lower Mackenzie (*Stringer,* O). — Lake Athabaska: Shelter Pt., no. 1378; Charlot Pt., nos. 6243, 6279; Fishhook Bay, no. 6585. Fort Smith, no. 1379; lower Slave R., no. 1380. Great Slave L.: *R. Bell,* no. 23160(O); S. W. and N. shores, *Howe,* no. 91995(O); N. W. shore, *Bedford* (O).

Antennaria nitida Greene. — Common in dry woods and prairies northward at least to the upper Mackenzie (*Dutilly*, G). — Lake Athabaska: Shelter Pt., no. 4452; base of Cornwall Bay, no. 6452; hills S. of Wabba L., no. 6472; 4 mi. E. of Wolverine Pt., no. 6802. East shore of L. Mamawi, no. 3317; Government Hay Camp district, Slave R., no. 3320. Great Slave L.: Fairchild Pt., no. 1372; Yellowknife Bay, no. 1371. Parry Falls, Lockhart R., *J. W. Tyrrell*, no. 23176(O)? (*A. exilis* of Tyrrell's list).

Antennaria campestris Rydb. — Occasional in dry prairies and on rocky shores northward to the western part of Great Slave Lake. — Lake Athabaska: Chipewyan, no. 6069; and *Harper*, no. 90115(O); Shelter Pt., no. 1376; Charlot Pt., nos. 6076, 6108, 6283. Great Slave L.: S. W. and N. shores, *Howe*, no. 91996(O).

Antennaria aprica Greene. — Occasional on the north shore of Lake Athabaska, and known on the Peace River (cited under *A. parvifolia* in Contr. Arnold Arb. **6:** 210). — Lake Athabaska: Chipewyan, no. 6071; Shelter Pt., no. 1373; Charlot Pt., nos. 6080, 6284.

Antennaria oxyphylla Greene. — Occasional in dry upland woods on the north shore of Lake Athabaska and along the Slave River, but not known elsewhere in the Mackenzie basin. — Lake Athabaska: Shelter Pt., no. 1374; Sand Pt., no. 4549; Cornwall Bay, no. 6464. Ft. Smith, no. 1375.

Gnaphalium uliginosum L. — Apparently rare in the Wood Buffalo Park and about the western end of Lake Athabaska, growing in damp sandy soils. Unknown elsewhere in the Mackenzie basin. — Chipewyan, no. 7016.

Xanthium italicum Mor. — *X. commune* Britton. — See Field Mus. Nat. Hist. Pub. Bot. **4:** no. 2 (1919), and Cornell Agr. Exp. Sta. Mem. **92:** 414 (1926). — Apparently confined to the southern part of the Mackenzie basin, and known only from the clayey banks of the lower Athabaska River. — McMurray, no. 7075.

Helianthus giganteus L. — Common on river banks about McMurray, but unknown farther north in the Mackenzie basin. — McMurray, nos. 1381, 7068.

Bidens cernua L. — Known in our region only in the Wood Buffalo Park, where it is common on marshy shores. — Reed Portage, upper Athabaska delta, no. 3327; Murdock Cr. district, no. 3328.

ANTHEMIS COTULA L. — Known only as a weed about settlements in the southern part of the region. — McMurray, no. 7098.

Achillea sibirica Ledeb. — *A. multiflora* Hook. — See Rhod. **31:** 219 (1929). — Common at lowland slough margins and on delta plains

northward at least to the Wood Buffalo Park, and known on the lower Mackenzie (*Onion, Kennicott & Hardisty,* N), but very little known east of the Paleozoic boundary. It was noted at Tsu Lake by Harper. — McMurray, no. 7112; Shelter Pt., no. 1404; E. shore of L. Mamawi, nos. 3368, 4395; upper Slave R. lowland, nos. 1403, 3370, 3371.

Achillea Millefolium L. — Common in prairies, damp meadows and clearings in the Wood Buffalo Park and southward. Also known on Great Bear Lake (*J. M. Bell,* O) and the Mackenzie (*Miss E. Taylor,* O). Eastward in the pre-Cambrian region it appears to be replaced in part at least by *A. borealis,* a closely related form. Owing to the great variation in this species complex certain of the following are placed here provisionally. — Calumet, Athabaska R., no. 1400. Lake Athabaska: Shelter Pt., nos. 1396, 1397; near eastern end, *J. W. Tyrrell,* no. 116957 (O) (var. *nigrescens* of Tyrrell's list). East shore of L. Mamawi, no. 3345; Gov. Hay Camp district, Slave R., nos. 3353, 3357, 3358; Ft. Smith (*Mrs. Conibear* coll.), nos. 1398, 1399. Great Slave L.: Keith Isl., no. 1402; Taltheilei Narrows, no. 1401.

Achillea borealis Bong. — A northern species, clearly represented in our region only on Lake Athabaska, where it grows on rocky or sandy shores and ridges. — Charlot Pt., nos. 6244, 6259; small island near base of Cornwall Bay, no. 6547; William Pt., no. 6857.

Achillea megacephala, sp. nov. PLATE 199[1]

Herba erecta 3–4 dm. alta, rhizomate perenni, caule striato leviter flexuoso arachneoso ad dense lanato; folia caulina 4–8 (plerumque circa 6), 2–12 cm. longa, 3–8 mm. lata, linearia vel oblanceolata, obtusa vel acuta, inferiores in petiolum angustata, omnia basi amplexicaulia, folia basalia 10–15 cm. longa, 6–10 mm. lata, oblanceolata ad linearia in petiolum angustata, folia omnia 2–3 pinnatifida, segmentis ultimis brevibus crassis ovatis, tomento albo lanato fere obscuratis, sed apices exteriorum glabrae saepe fulvo-tinctae in setam albam hyalinam circa 3 mm. longam e basi hyalina excurrentes. Inflorescentia corymbiformis, 3–8 cm. lata; involucra basi rotundata, 5–7 mm. alta (pleraque circa 6–7 mm.), 4–6 mm. lata (pleraque circa 5 mm.); bracteae manifeste imbricatae, obtusae vel rotundatae, superiores ad marginem sericeae ad lanatae, costa rigida conspicua hyalina in medio interdum fulvo-tincta, margine late lacerato scarioso interdum tenuiter fulvo-tincto; ligulae circa 5, 2.5–3 mm. longae, 3–3.5 mm. latae, pleraeque trilobatae, albae; capitula circa 25-flora, receptaculo breviter conico, fere alto quam lato; achaenia circa 2 × 0.8 mm., leviter complanata, ad apicem latissima, alba, medio fusco, stipite distincto.

[1]PLATE 199. *Achillea megacephala* Raup. Part of type collection from sand dunes southwest of William Pt., Lake Athabaska; no. 6913; details × 2.

On large shifting sand dunes southwest of William Point, Lake Athabaska, Aug. 20, 1935, no. 6913 (Type, G). Number 6890, collected in the same dune area on Aug. 16, 1935, but about 4 miles to the eastward, may also be referred to this species.

The complex series of forms centering around *Achillea Millefolium* L. and its close relatives in America (chiefly *A. borealis* Bong. and the so-called *A. lanulosa* Nutt.) is not well understood, but it is uniform in having involucres which are rather wedge-shaped at the base, and from 3 to 6 mm. high (usually 4–5 mm.). *A. megacephala* differs from these forms in having a larger involucre (seldom under 5 mm. and mostly 6–7 mm.), the base of which is well-rounded when mature. Its leaves most nearly resemble those of the tomentose forms *A. Millefolium* commonly designated *A. lanulosa*. Its showy rays resemble those of *A. borealis*, but the scarious-margined bracts, scarcely tinged with brown, suggest the eastern *A. Millefolium*.

CHRYSANTHEMUM LEUCANTHEMUM L. var. PINNATIFIDUM Lecoq & Lamotte. — Collected thus far only in a cabin clearing in the Wood Buffalo Park.

Tanacetum huronense Nutt. var. **bifarium** Fern. — See Rhod. **37**: 333–4 (1935). — Common on sandy beaches on the northwest shore of Lake Athabaska. Noted in Fl. Bor.-Am., under *T. pauciflorum*, as occurring "between lat. 54° and 64°," but the following are the only specimens seen by the writer. — Lake Athabaska: Shelter Pt., nos. 1382, 1383, 4431; Sand Pt., no. 4490.

Tanacetum huronense Nutt. var. **floccosum**, var. nov. PLATE 200[1]

A forma typica differt caulibus floriferis brevioribus (2–4 dm.), et corymbis capitulos 1–6 gerentibus. A var. *bifario* Fern. differt pinnis et pinnulis magis confertis, et tota herba tomento albo floccoso vestita.

Dry sandy upper beach on the south shore of Lake Athabaska near Wolverine Point, July 28, 1935, no. 6719 (Type, G). Another number, 6912, collected in the large dune area southwest of William Point on Aug. 20, 1935, is a good match for the type.

These plants are quite distinctive on account of their heavy white tomentum, and are among the more important dune-fixing plants on the south side of Lake Athabaska. They commonly grow in large clumps with extensively ramifying root systems. Their nearest relationship seems to be with *T. huronense* Nutt. var. *bifarium* Fern.[2] which

[1]PLATE 200. *Tanacetum huronense* Nutt. var. *floccosum* Raup. Part of type collection from a sandy beach near Wolverine Pt., Lake Athabaska, no. 6719. Habit photo taken in sand dune country southwest of William Pt., Aug. 20, 1935.

[2]See Rhod. **37**: 333–4 (1935) for a recent revision of this species complex.

is a few-flowered form of about the same stature and leaf-shape. Variety *bifarium* is common on the sandy northwestern shores of Lake Athabaska.

Artemisia canadensis Michx. — Occasional to common in dry prairies and on sandy or rocky shores and hills. Known on the lower Mackenzie (*Miss E. Taylor,* O). Mackenzie basin records of *A. desertorum* in Fl. Bor.-Am. probably refers to this species. — Calumet, Athabaska R., no. 1394. Lake Athabaska: Chipewyan, nos. 4676, 7030; and *Dutilly,* no. 144(G); Shelter Pt., nos. 1389, 1391; Sand Pt., no. 4556; shore of main lake just W. of Ellis Bay, no. 6265; Charlot Pt., no. 6291; hills of Wabba L., no. 6468; Cornwall Bay, no. 6570; along Archibald R., S. of Wolverine Pt., no. 6732. Fort Smith (*Mrs. Conibear,* coll.), no. 1388. Great Slave L.: Resolution, *Onion, Kennicott & Hardisty* (N); Taltheilei Narrows, nos. 1390, 1392; Fairchild Pt., no. 1393; Ft. Reliance, no. 1395.

Artemisia borealis Pall. — Common on dunes and on sandy or gravelly beach ridges in the pre-Cambrian country. — Lake Athabaska: 2 mi. E. of Wolverine Pt., nos. 6709, 6718; near Archibald R., S. of Wolverine Pt., no. 6747; big dunes 5 mi. S. of William Pt., no. 6893; dunes just E. of Ennuyeuse Cr., nos. 6914, 6924. Great Slave L.: Fairchild Pt., nos. 1386, 1387; Ft. Reliance, no. 1385.

Artemisia dracunculoides Pursh. — Occasional or common northward to the Wood Buffalo Park where it grows in dry prairies, but unknown east of the Paleozoic boundary. — McMurray, *Harper,* no. 90118(O).

Artemisia biennis Willd. — Occasional in meadows and clearings, and on stream banks northward to the Mackenzie (*Onion & Ross,* N), but not known in the pre-Cambrian country. — McMurray, no. 7055; Reed Portage, upper Athabaska delta, no. 3343.

Artemisia frigida Willd. — Common on dry river bluffs and rocky hills northward to Lake Athabaska and the Wood Buffalo Park, and known on the lower Mackenzie (*McConnell,* O; *Miss E. Taylor,* O). Noted by Preble at the rapids of the Athabaska. — Lake Athabaska: Chipewyan, *Dutilly,* no. 143(G); Shelter Pt., no. 1384. East shore of L. Mamawi, no. 3335.

Artemisia Tilesii Ledeb. — See Contr. Arnold Arb. **6**: 211–12 (1934). — Occasional on river banks and lake shores in the Peace and Athabaska River regions, and on Great Bear Lake (*Richardson,* O; *J. M. Bell,* O) and the lower Mackenzie (*Onion,* N). The writer has seen no material from about Athabaska and Great Slave Lakes. — McMurray, no. 7074; along Athabaska R. below MacKay, no. 6001.

Petasites palmatus (Ait.) Gray. — Common in open woods and at muskeg margins northward at least to Lake Athabaska and the Wood Buffalo Park, and known at Great Bear Lake (*J. M. Bell*, no. 22930, O); muskeg S. of Wabba L., no. 6488; along William R. near its mouth, no. 6897. Fort Smith, no. 1435. Taltheilei Narrows, Great Slave L., no. 1436.

Petasites vitifolius Greene. — Occasional to common in upland muskegs and wet meadows northward to the Mackenzie (*Onion*, N). — Lake Athabaska: hills N. E. of Cornwall Bay, no. 6540. Resolution, *Kennicott* (N)?

Petasites sagittatus (Pursh) Gray. — Abundant in wet meadows and muskegs northward at least to the Wood Buffalo Park, and occasional on Great Slave Lake, but not yet collected on Lake Athabaska. Noted by Richardson "to Fort Franklin." — Government Hay Camp district, Slave R., no. 3415. Great Slave L.: Fairchild Pt., nos. 1433, 1434.

Arnica chionopappa Fern. — See Rhod. **35:** 336–7 (1933). — Common in dry upland woods throughout the region, and known on the lower Mackenzie (*Dutilly*, G; *Onion*, N). — Lake Athabaska: Shelter Pt., nos. 1411, 1412; Charlot Pt., nos. 6127, 6222, 6231, 6260; Camsell Portage, no. 6194; hills N. E. of Cornwall Bay, no. 6519; Fishhook Bay, no. 6577; "Cumberland and Chepewyan," *Richardson* (O) (*A. montana* of Fl. Bor.-Am. in part). Government Hay Camp district, Slave R., no. 3377; Ft. Smith, no. 1408; and *Seton & Preble*, no. 78293 (O) (*A. angustifolia* of Seton's list); lower Slave R., no. 1409. Great Slave L.: Fairchild Pt., nos. 1407, 1410; N. W. shore, *Bedford* (O); Old Fort Rae, *Russell* (O); Windy Pt., *Hume*, no. 102689(O).

Arnica attenuata Greene. — Apparently occasional to common on rocky uplands and shores about Great Slave Lake and northward, but rare on Lake Athabaska. Tyrrell's record for *A. alpina* on Lake Athabaska, probably refers to this species. The note in Fl. Bor.-Am., under *A. montana*, "from the Saskatchewan to the extreme Arctic regions" also probably belongs here at least in part. — Lake Athabaska: small island near base of Charlot Pt., no. 6376. Great Slave L.: Taltheilei Narrows, no. 1406; Fairchild Pt., no. 1405.

Arnica rhizomata A. Nels. — Common at the margins of dry upland prairies in the Wood Buffalo Park, but unknown elsewhere in our region. It has been collected on the Peace River, and a specimen in Herb. N collected by Kennicott somewhere on the Mackenzie has been referred to it somewhat doubtfully.

Senecio eremophilus Richards. — Occasional in lowland clearings

and wet meadows along the upper Slave and lower Athabaska Rivers. Noted by Richardson northward "to Fort Franklin." — Reed Portage, upper Athabaska delta, no. 3391; Gov. Hay Camp district, Slave R., nos. 3392, 3393.

Senecio indecorus Greene. — See Rhod. **26:** 120 (1924). — Common in lowland wet meadows and occasional at upland prairie margins in the Wood Buffalo Park, and known far northward in the Mackenzie region (*Richardson,* O; *Onion,* N). Apparently rare or occasional east of the Paleozoic boundary. Part of the material referred to *S. aureus* in Fl. Bor.-Am., Macoun's Cat., and Back's Narrative evidently belongs here. — Lake Athabaska: Shelter Pt., no. 1415; near base of Cornwall Bay. no. 6480. Upper Slave R. lowland, nos. 3387, 3388.

Senecio pauperculus Michx. — See Rhod. **23:** 299 (1921). — Common in muskegs, rich woods, and on damp meadows and shores on the north side of Lake Athabaska and in the Wood Buffalo Park, but apparently only occasional northward. The note under *S. Balsamitae* in Fl. Bor.-Am. "Woody country, from lat. 54° to 64°," probably refers to this species in part. — Calumet, Athabaska R., no. 1416. Lake Athabaska: Charlot Pt., nos. 6250, 6377; Cornwall Bay, no. 6546; Fishhook Bay, no. 6583. Upper Slave R. lowland, nos. 3394, 3398; lower Slave R., no. 1417. Great Slave L.: Fairchild Pt., no. 1418.

Senecio cymbalarioides Nutt. var. **borealis** (T. & G.) Greenm. — See Ann. Mo. Bot. Gard. **3:** 177 (1916). — Common on dry uplands and shores about Great Slave Lake, and occasional on Lake Athabaska and in the Wood Buffalo Park. Also known on the Mackenzie (*Dutilly,* G; *Onion & Ross,* N). — Lake Athabaska: near Chipewyan, *Harper,* no. 90127(O); N. shore, *J. W. Tyrrell* (O); Charlot Pt., nos. 6086, 6282; Black Bay, *Harper,* no. 90126(O). Fort Smith, nos. 1424, 1429; and *Seton & Preble,* no. 78580(O); and *Miss E. Taylor,* no. 14790(O); Hill Island L., *Harper,* no. 90130(O); Togun R., between Athabaska and Great Slave Lakes, *Harper,* no. 90129. Great Slave L.: Caribou Isl., *Seton & Preble,* no. 78581(O); Taltheilei Narrows, nos. 1423, 1427; base of Maufelly Pt., no. 1428; Fairchild Pt., nos. 1425, 1426, 1430, 1431; Windy Pt., *Hume,* no. 102688(O); S. W. and N. shores, *Howe,* no. 91998(O); N. W. shore, *Bedford* (O).

Senecio palustris (L.) Hook. — Common in lowland sloughs and wet meadows about the western end of Lake Athabaska and northward to the Arctic, but very little known in our region eastward of the Paleozoic boundary. — Reed Portage, upper Athabaska delta, no. 3388; lower delta, no. 1420; Shelter Pt., L. Athabaska, no. 1421; upper Slave R. lowland, nos. 1419, 3384. Great Slave L.: N. W. shore, *Bedford* (O).

Senecio pauciflorus Pursh. — The type of this species came from

Fort Franklin, and the range is given in Fl. Bor.-Am. as "Woody country between lat. 54° and 64°." The writer has seen no material from south of Great Slave Lake. — Great Slave L.: Resolution, *Harper,* no. 90128 (O); Ft. Rae, *Russell* (O).

Cirsium Drummondii T. & G. — Common in prairies and the drier parts of wet meadows in the Wood Buffalo Park, but not known elsewhere in our region. It extends northward to Ft. Franklin (*Richardson,* G), and is known in the northern Rockies. — Upper Slave R. lowland, nos. 1437, 3422.

Saussurea alpina DC. — A record for *S. alpina* var. *remotifolia,* "North of the Saskatchewan to the Bear Lake, in lat. 66° North," occurs in Fl. Bor.-Am., but there is no other evidence of the species in our region except the following. — Stony Island, Great Slave L., *J. W. Tyrrell,* no. 23186(O) (*S. monticola* of Tyrrell's list.)

Agoseris glauca (Pursh) D. Dietr. — Known in our region only on a muddy shore at the eastern end of Great Slave Lake. Part of the material noted in Fl. Bor.-Am. under *Traximon glaucum* "from lat. 49° northward to the Arctic Coast" probably belongs here. — Fairchild Pt., Great Slave L., no. 1438.

Hieracium canadense Michx. — Common in upland open woods and thickets, and on sandy or rocky shores northward to Great Slave Lake, and known on the Mackenzie (*Onion,* N). An extremely variable species, possibly containing more than one entity, and possibly separate from the eastern *H. canadense.* — Lake Athabaska: Chipewyan, no. 7027; and *Dutilly,* no. 142(G); Shelter Pt., nos. 1439, 1440, 1441, 1443; Sand Pt., nos. 4546, 4648; Cornwall Bay, no. 6466; beach about 2 mi. E. of Wolverine Pt., no. 6705; William Pt., no. 6856. East shore of L. Mamawi, nos. 3432, 4414; Gov. Hay Camp district, Slave R., nos. 3423, 3424. Great Slave L.: S. W. and N. shores, *Howe,* no. 91997(O); N. W. shore, *Bedford* (O).

TARAXACUM OFFICINALE Weber. — Occasional as an introduced weed in waste places about settlements. — Chipewyan, no. 6062.

Taraxacum ceratophorum Ledeb.) DC. — See Rhod. **35:** 369–86 (1933) for a treatment of this and the following species of *Taraxacum.* — Occasional in open woods, clearings, and rock crevices northward at least to Lake Athabaska and the Wood Buffalo Park. A Mackenzie River specimen (*Onion,* N) has been referred here provisionally. — Lake Athabaska: dolomitic hills N. E. of Cornwall Bay, no. 6524. — Calumet, Athabaska R., no. 1445.

Taraxacum dumetorum Greene. — Occasional in open woods, clearings and prairies northward at least to Great Slave Lake. — Gov. Hay Camp district, upper Slave R., no. 3441; Ft. Smith, no. 1446. —

Great Slave L.: Taltheilei Narrows, no. 1447.

Taraxacum lacerum Greene. — Occasional to common in damp crevices and on gravel beaches among conglomerate rocks on the north shore of Lake Athabaska. A sterile specimen from sandstone rocks at Sand Pt. is referred here provisionally. — Charlot Pt., L. Athabaska, nos. 6232, 6251.

Taraxacum lapponicum Kihlm. — An arctic species known in our region only on the north shore of Lake Athabaska, where it is occasional in crevices in conglomerate rocks. — Charlot Pt., L. Athabaska, no. 6247.

Lactuca pulchella (Pursh) DC. — Common in clearings and on stream banks northward to Great Bear Lake and the Mackenzie (*Richardson,* O, noted under *Sonchus sibiricus* in Fl. Bor.-Am.; *Miss E. Taylor,* O), but not known east of the Paleozoic boundary. — McMurray, no. 7053; Reed Portage, upper Athabaska delta, no. 3433; upper Slave R. lowland, nos. 3434, 3436; lower Slave R., no. 1444.

SONCHUS ARVENSIS L. var. GLABRESCENS Guenth., Wimm. & Grab. — See Rhod. **12:** 145 (1910); **30:** 19 (1928). — An introduced weed known only in settlements in the southern part of the region. — Waterways, no. 3448.

LIST OF UNVERIFIED RECORDS

Some of the names noted below were based upon specimens which are known to have been lost, while others are supported by material which the writer has been unable to check. Still another category includes those based upon the ambiguous statements which commonly occur in the earlier works, such as "Cumberland House to Bear Lake." Some of these unverified records are extremely questionable, like the occurrence of *Antennaria plantaginifolia* at Great Slave Lake. Others, such as the report of *Acer spicatum* at Chipewyan, are distinctly worthy of further investigation, particularly since the Athabaska Lake district has proved fruitful of long range extensions from the surrounding regions.

THELYPTERIS CRISTATA (L.) Nieuwl. — "Northward as far as Great Slave Lake" (*Macoun's Cat.,* under *Aspidium cristatum*).

ASPLENIUM TRICHOMANES L. — Clearwater R., near Methye Portage (*Macoun's Cat.*).

LYCOPODIUM ALPINUM L. — White Island, 50 mi. N. of Resolution (*J. W. Tyrrell*).

CALAMAGROSTIS NEGLECTA (Ehrh.) Gaertn. var. MICRANTHA (Kearney) Stebbins. — Athabaska Landing (*Hitchcock,* cited by Stebbins, Rhod. **32:** 55).

CALAMAGROSTIS INEXPANSA Gray var. TYPICA Stebbins. — Athabaska Landing (*Hitchcock,* cited by Stebbins, Rhod. **32**: 48).

ERIOPHORUM GRACILE Koch. — "Saskatchewan to Arctic America" (*Fl. Bor.-Am.*).

SCIRPUS AMERICANUS Pers. — Records under *S. triqueter* in Fl. Bor.-Am. and under *S. pungens* in Macoun's Cat. may refer to this species: throughout the country "to the Arctic regions."

KOBRESIA BELLARDI (All.) Degl. — A record in Fl. Bor.-Am., "Wooded country. Dr. Richardson," under *Carex affinis,* is doubtfully referred here.

CAREX PRAIREA Dewey. — A record in Macoun's Cat., "northward to Lake Athabasca," under *C. teretiuscula* var. *ramosa* may refer to this species.

CAREX LANUGINOSA Michx. — Methye Portage (*Richardson,* 1845).

CAREX HOUGHTONII Torr. — "Cumberland House to Fort Chipewyan" (*Richardson,* O).

CAREX ROTUNDATA Wahl. — "Slave Lake, and Fort Enterprise" (*Fl. Bor.-Am.*).

TRILLIUM CERNUUM L. var. MACRANTHUM Eames & Wieg. — See Rhod. **25**: 189 (1923). — "From Saskatchewan to Mackenzie River" (*Fl. Bor.-Am.*). A Richardson specimen in Herb. G. is marked "Mackenzie River."

SALIX AMMANIANA Richardson. — A Richardson specimen in Herb. O (N. E.) is labeled Slave River. Hooker apparently referred *S. Ammaniana* to *S. Uva-ursi* (Fl. Bor.-Am. **2**: 152), also a species otherwise unknown in the Mackenzie basin.

SALIX RICHARDSONII Hook. — Pike's Portage and Artillery L. (*J. W. Tyrrell*).

CORYLUS AMERICANA Marsh. — Common on the road a few miles south of Athabaska Landing. "This is its northern limit . . ." (*Preble*).

POLYGONUM COCCINEUM Muhl. — See Rhod. **27**: 156 (1925). — Records for *P. Muhlenbergii* made by Harper on the Athabaska near Cascade Rapid may refer to this species.

CHENOPODIUM HYBRIDUM L. — "Northward to Bear Lake, Lat. 64" (*Macoun's Cat.*), evidently based on the record in Fl. Bor.-Am. under *C. urticum.*

ATRIPLEX NUTTALLII Wats. — A record in Fl. Bor.-Am., "Salt marshes of the Saskatchewan and of Slave River," under *A. canescens,* may be referable to this species.

SILENE MENZIESII Hook. — "Portage D'Embarras, Slave River" (*Fl. Bor.-Am.*).

DRABA INCANA L. var. CONFUSA (Ehrh.) Liljebl. — See Rhod. **36**:

315 (1934). — "North in the plains, nearly to the mouth of the Mackenzie River" (*Fl. Bor.-Am.*, under *D. confusa*).

POTENTILLA DISSECTA Pursh. — "Great Slave Lake (*McGill Coll. Herb.*)" (*Macoun's Cat.*).

ASTRAGALUS ABORIGINORUM Richards. — "From Lake Winipeg to the Rocky Mountains and as far north as Bear Lake . . ." (*Fl. Bor.-Am.*, under *Phaca aboriginorum*).

ACER SPICATUM Lam. — Chipewyan (*J. W. Tyrrell*). The writer has searched repeatedly but in vain for this species at Chipewyan and elsewhere on Lake Athabaska.

VIOLA OCHROLEUCA Schwein. — "Woody country, from lat. 54° to 64°. ? *Dr. Richardson*" (*Fl. Bor.-Am.*).

SHEPHERDIA ARGENTEA Nutt. — "Left bank of the Athabaska, below Brule Rapid" (*Seton*).

EPILOBIUM MOLLE Torr. — "In boggy ground, Lake Athabasca" (*Macoun's Cat.*).

OENOTHERA BIENNIS L. — "Athabasca" (*Bot. App. to Back's Narrative*).

GENTIANA PROPINQUA Richards. — "Cumberland House to Bear Lake . . ." (*Fl. Bor.-Am.*).

GENTIANA TENUIS Griseb. — "Cumberland House to Bear Lake" (*Fl. Bor.-Am.*).

SCUTELLARIA LATERIFLORA L. — "Northward to Lake Athabasca" (*Macoun's Cat.*).

LONICERA VILLOSA (Michx.) R. & S. var. ? — A record in Fl. Bor.-Am. under *L. caerulea*, "Throughout the wooded country and as far north as lat. 66°" may refer to this species, which occurs in the Lesser Slave Lake district.

SYMPHORICARPOS VACCINOIDES Rydb. — Sterile specimens doubtfully determined thus were collected by the writer along the Quatre Fourches R., no. 1321.

VIBURNUM TRILOBUM Marsh. — Notes under *V. opulus* by Preble, "not observed north of the junction of the Athabaska and the Clearwater. South of this point it is abundant . . .," and by Seton, "along the Athabaska at Fort McKay," may refer to this species.

LOBELIA DORTMANNA L. — Slave Lake and small lake at the summit of Portage La Loche (*Fl. Bor.-Am.*).

EUPATORIUM PURPUREUM L. — "North to the Clearwater River. Lat. 57°" (*Macoun's Cat.*).

SOLIDAGO JUNCEA Ait. — "Woody country between lat. 54° and 64°" (*Fl. Bor.-Am.*).

ALNUS CRISPA var. ELONGATA Raup

FULL-TONE — MERIDEN

STELLARIA ARENICOLA Raup

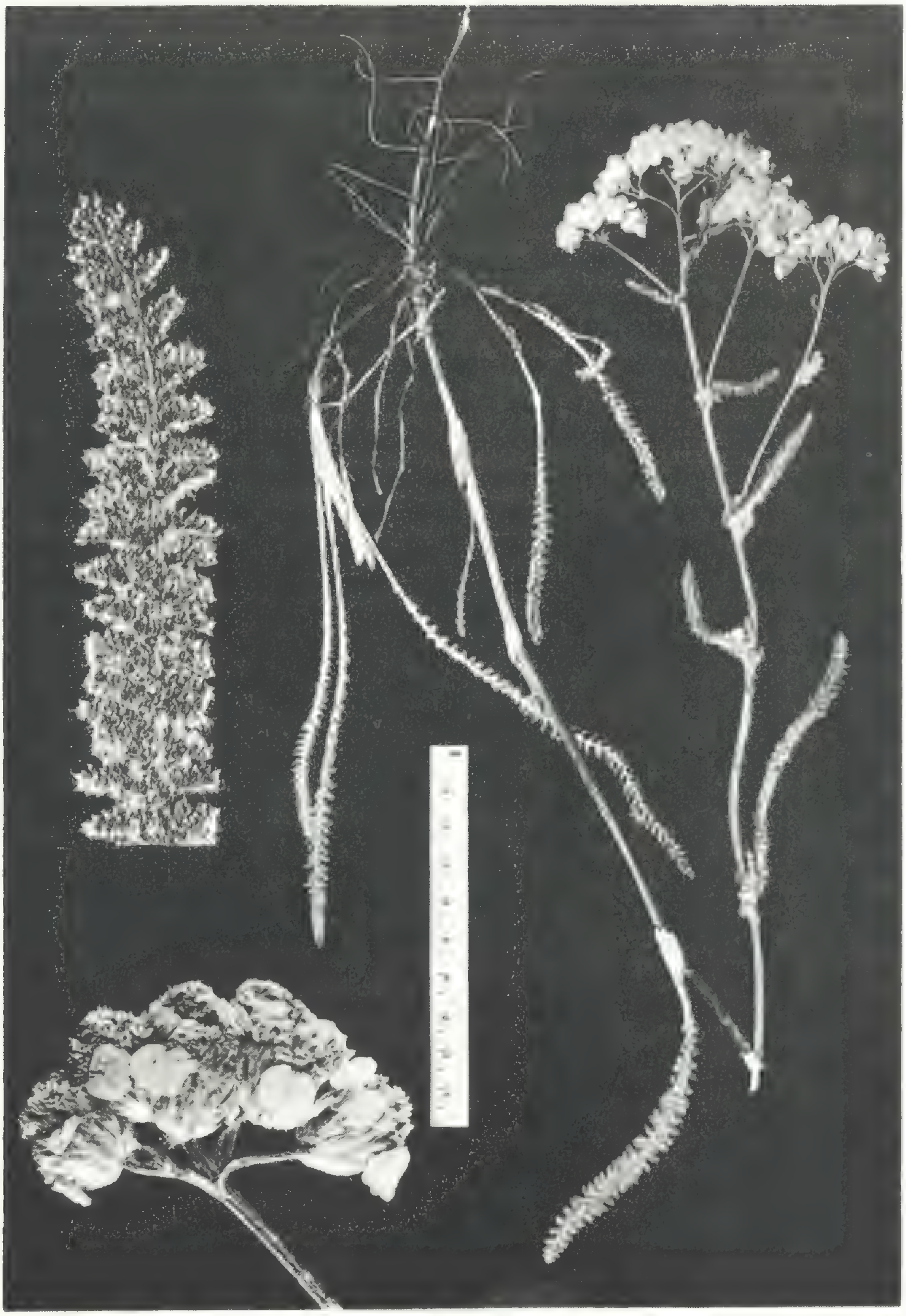
FULL-TONE — MERIDEN

CICUTA MACKENZIEANA Raup

FULL-TONE — MERIDEN

STATICE INTERIOR Raup

FULL-TONE — MERIDEN



ACHILLEA MEGACEPHALA Raup

FULL-TONE — MERIDEN

TANACETUM HURONENSE var. FLOCCOSUM Raup

FULL-TONE — MERIDEN

ASTER ANGUSTUS T. & G. — "Slave Lake" (*Fl. Bor.-Am.*, under *Tripolium angustum*); "northward to Lake Athabaska" (*Macoun's Cat.*).

ERIGERON SALSUGINOSUS Gray. — "Salt plains of the Athabasca. Dr. Richardson." (*Fl. Bor.-Am.*, under *Aster salsuginosus*).

ANTENNARIA PLANTAGINIFOLIA Hook. — Great Slave Lake (Bot. *App. to Back's Narrative*, under *A. plantaginea*).

HELENIUM AUTUMNALE L. — "From Lake Huron nearly to the Arctic Circle . . ." (*Fl. Bor.-Am.*).

SENECIO INTEGRIFOLIUS Nutt. — "Woody country, in lat. 54°, to the shores of the Arctic sea" (*Fl. Bor.-Am.*); referred to *S. Hookeri* in Macoun's Cat.

ADDITIONS

The following species were overlooked in the preparation of the first part of the catalogue.

Pinus contorta Loudon var. **latifolia** Engelm. ex Wats. — *P. Murrayana* Balf. — *P. contorta* var. *Murrayana* (Balf.) Engelm. — A cordilleran species known in our region only on the southwestern uplands of the Wood Buffalo Park.

Potamogeton panormitanus Biv. — Known in our region only from an upland lake in the Wood Buffalo Park.

Potamogeton filiformis Pers. var. **Macounii** Morong. — Occasional in shallow lakes and slow streams in the Wood Buffalo Park.

Najas flexilis (Willd.) Rostk. and Schmidt. — Rare or occasional in upland lakes in the Wood Buffalo Park.

SUMMARY OF PLANTS TREATED IN THIS CATALOGUE

	Families	Genera	Species	Vars. and forms	Total number of different plants[1]
Pteridophyta	6	13	36	8	39
Gymnospermae	1	5	8	2	8
Monocotyledoneae	14	67	215	44	227
Archichlamydeae	36	97	262	44	280
Metachlamydeae	22	85	175	33	185
Totals	79	267	696	131	739

HERBARIUM, ARNOLD ARBORETUM,
HARVARD UNIVERSITY.

[1]There are 88 species which are represented only by one or more varieties or forms. The figures for the total number of different plants are obtained by subtracting these species from the total number of species, varieties, or forms.

NOTES ON THE LIGNEOUS PLANTS DESCRIBED BY H. LEVEILLE FROM EASTERN ASIA[1]

ALFRED REHDER

POLYGONACEAE[2]

Polygonum emodi Meisn. var. **dependens** Diels. — Rehder in Jour. Arnold Arb. **10:** 184 (1929). — Samuelsson in Handel-Mazzetti, Symb. Sin. **7:** 176 (1929). — Steward in Contrib. Gray Herb. **88:** 29 (1930).

Polygonum zigzag Léveillé & Vaniot (1908). — Léveillé in Bull. Soc. Bot. France, **57:** 447 (1910).

Bistorta zigzag (Lévl.) Gross in Bull. Géog. Bot. **23:** 19 (1913).

Polygonum cuspidatum Siebold & Zuccarini in Abh. Akad. Wiss. Muench. **4**, pt. 3, p. 208 (Fl. Jap. Fam. Nat. **2:** 84) (1846). — Samuelsson in Handel-Mazzetti, Symb. Sin. **7:** 185 (1929). — Steward in Contrib. Gray Herb. **88:** 97 (1930).

Polygonum yunnanense Léveillé in Fedde, Rep. Spec. Nov. **6:** 112 (1908).

CHINA. Yunnan: Yunnan-sen, buissons, *F. Ducloux,* no. 539, Aug. 15, 1905 (holotype of *P. yunnanense;* photo. in A. A.).

Polygonum yunnanense seems to have been first identified with *P. cuspidatum* by H. Gross, according to a note on the type specimen dated 1912, where the name is transferred as a variety to *Pleuropterus cuspidatus,* but the varietal combination was apparently never published. Handel-Mazzetti (l.c.) cites *P. yunnanense* Lévl. (1908), non Cat. Pl. Yun-Nan, 208 (1916) as a synonym. Steward does not cite the name, but the type specimen Ducloux 539 under *P. cuspidatum.*

The correct name of the species is *P. cuspidatum* Sieb. & Zucc., for *P. cuspidatum* Willd. ex Sprengel (1825) was published as a synonym of *P. acuminatum* Kunth. Therefore, *P. Zuccarinii* Small (1895) and *P. Sieboldii* De Vriese ex Bailey (1901) proposed as new names for *P. cuspidatum* Sieb. & Zucc., not Willd., become synonyms of *P. cuspidatum* Sieb. & Zucc. As far as I can find, *P. Sieboldii* was never used as a valid name before being taken up by Bailey. In the citations given

[1]Continued from Vol. **17:** 53–82; for preceding parts see Vols. **10:** 108–132, 164–196; **12:** 275–281; **13:** 299–332; **14:** 223–252; **15:** 1–27, 89–117, 267–326; **16:** 311–340.

[2]See Jour. Arnold Arb. **10:** 184.

by Meisner in DC. Prodr. **14:** 136 under *P. Sieboldii* that name appears only as a synonym of *P. cuspidatum.*

Polygonum urophyllum Franchet & Bureau. — Rehder in Jour. Arnold Arb. **10:** 184 (1929). — Samuelsson in Handel-Mazzetti, Symb. Sin. **7:** 186 (1929). — Steward in Contrib. Gray Herb. **88:** 116 (1930).

Fagopyrum Mairei (Lévl.) H. Gross in Bull. Géog. Bot. **23:** 25 (1913).

Polygonum Mairei Lévl. is cited as a synonym of *P. urophyllum* by Samuelsson and by Steward.

Polygonum Statice Léveillé in Fedde, Rep. Spec. Nov. **7:** 338 (1909); in Bull. Soc. Bot. France, **57:** 446 (1910); Fl. Kouy-Tchéou, 321 (1915). — Samuelsson in Handel-Mazzetti, Symb. Sin. **7:** 186 (1929). — Steward in Contrib. Gray Herb. **88:** 115 (1930).

Fagopyrum Statice (Lévl.) H. Gross in Bull. Géog. Bot. **23:** 26 (1913).

Polygonum multiflorum Thunberg sensu Rehder in Jour. Arnold Arb. **10:** 185 (1929), quoad syn. *P. Statice* Lévl.; non Thunberg.

China. Kweichou: without precise locality, *J. Esquirol,* no. 164 (holotype; ex Léveillé).

I had placed *P. Statice* Lévl. on the authority of Dr. Samuelsson (in litt.) under *P. multiflorum* Thbg., but apparently on closer study, he found that it represents a distinct species related to *P. urophyllum* Franch. & Bur. I have not seen the type specimen.

RANUNCULACEAE[1]

Clematis ranunculoides Franch. var. **tomentosa** Finet & Gagnepain in Bull. Soc. Bot. France, **50:** 544 (1903); Contrib. Fl. As. Or. **1:** 29 (1905).

Clematis urophylla Franch. var. *heterophylla* Léveillé in Bull. Acad. Intern. Géog. Bot. 17, no. 210–211, p. ii (1907). — **Synon. nov.**

Clematis urophylla Franch. sensu Léveillé, Fl. Kouy-Tchéou, 334 (1915) pro parte, quoad specim. Esquirol 763; vix Franchet.

? *Clematis Mairei* Léveillé in Fedde, Rep. Spec. Nov. **7:** 337 (1909); Cat. Pl. Yun-Nan, 222 (1917).

China. Kweichou: without locality, *J. Esquirol,* no. 763 (holotype of *C. urophylla* var. *heterophylla;* photo. in A. A.). Yunnan: Tong-chan, taillis et fourrets de la montagne, *E. E. Maire,* no. 381, June 19, 1905 (holotype of *C. Mairei;* ex Léveillé).

This variety looks quite distinct from typical *C. ranunculoides,* but seems to be connected by intermediate forms, such as Henry no. 9326

[1]See Jour. Arnold Arb. **10:** 185.

from Mengtze, 4600 ft. "red fls., erect plant," while another specimen under the same number with the note "low hills" agrees well with the var. *tomentosa*. The color of the flowers varies from white to rose-colored. The type of *C. Mairei* cannot be located in the Herb. Léveillé, but according to the description, it probably belongs here.

Clematis trullifera Finet & Gagnepain in Bull. Soc. Bot. France, **50**: 547 (1903); Contrib. Fl. As. Or. **1**: 32 (1905). — Léveillé, Cat. Pl. Yun-Nan, 222 (1917). — Handel-Mazzetti, Symb. Sin. **7**: 319 (1929).

Clematis coriigera Léveillé in Fedde, Rep. Spec. Nov. **12**: 281 (1913). — **Synon. nov.**

CHINA. Yunnan: haies, plaine de Tong-tchouan, alt. 2500 m., *E. E. Maire*, Sept. 1912, "Clematis grimpant à long rameaux, fleurs jaunes" (holotype of *C. coriigera;* photo. in A. A.).

Handel-Mazzetti cites (l.c.) a Maire specimen from the same locality, spelled by him "Dungtschwan" which is probably an isotype, but he does not mention Léveillé's name. *Clematis coriigera* is not enumerated by Léveillé in his Cat. Pl. Yun-Nan, neither as a valid species nor as a synonym of *C. trullifera*.

Clematis grata Wall. var. **argentilucida** (Lévl. & Vant.), comb. nov.

Clematis Vitalba L. var. *argentilucida* Léveillé & Vaniot in Bull. Acad. Intern. Géog. Bot. **11**: 167 (1902).

Clematis Vitalba γ *Cl. grata* (Wall.) Finet & Gagnepain in Bull. Soc. Bot. France, **50**: 532 (1903); Contrib. Fl. As. Or. **1**: 17 (1905), p.p., tandem quoad specim. cit. "Bodinier no. 1621."

Clematis grata var. *grandidentata* Rehder & Wilson in Sargent, Pl. Wilson. **1**: 338 (1913). — **Synon. nov.**

CHINA. Kweichou: environs de Kouy-yang, commun dans les haies de la plaine, *E. Bodinier*, no. 1621, June 10, 1897 "fleurs blanches"; Collège, *E. Bodinier*, July 3, 1900 (syntypes of *C. Vitalba* var. *argentilucida;* photos. in A. A.).

The fact that Léveillé and Vaniot's varietal epithet antedates *C. grata* var. *grandidentata* makes a new combination necessary.

Clematis Gouriana Roxburgh ex De Candolle, Syst. **1**: 138 (1818). — Rehder in Jour. Arnold Arb. **10**: 188 (1929).

Clematis substipulata Kuntze in Verh. Bot. Ver. Brandenb. **26**: 100 (Monog. Clem.) (1885).

Clematis Vitalba L. var. *micrantha* Léveillé & Vaniot in Bull. Acad. Intern. Géog. Bot. **11**: 167 (1902). — Léveillé, Cat. Pl. Yun-Nan, 222 (1917).

Clematis Vitalba L. var. β *Cl. Gouriana* f. *substipulata* (Ktze.) Finet

& Gagnepain in Bull. Soc. Bot. France, **50**: 532 (1903); Contrib. Fl. As. Or. **1**: 17 (1905).

Clematis Martini Léveillé in Bull. Acad. Intern. Géog. Bot. *27*, no. 210–211, p. ii (1907); Fl. Kouy-Tchéou, 333 (1915).

China. Kweichou: environs de Gan-pin, haies de la montagne, *L. Martin* in herb. *Bodinier*, no. 1884, Sept. 4, 1897, "fleurs blanches" (holotype of *C. Vitalba* var. *micrantha;* photo. in A. A.); Gan-chouen, *J. Cavalerie*, no. 3831, in 1910, "fleure blanche" (cited in Fl. Kouy-Tchéou under *C. Vitalba* var. *Gouriana;* photo. and merotype in A. A.); route de Pien-yang à Lo-fou, *J. Cavalerie*, no. 2662, Nov. 1905 (syntype of *C. Martini;* photo. in A. A.); bord du fleuve Hoa-kiang, *J. Esquirol*, no. 576, Aug. 5, 1905 (syntype of *C. Martini;* merotype in A. A.); Lo-fou, *J. Cavalerie*, no. 3583, March 1909 (sub *C. Martini* in Fl. Kouy-Tchéou; duplicate in A. A.).

It does not seem advisable to maintain *f. substipulata* as a distinct form or variety, since the stipules or bracts constitute a rather unstable character and may be present or absent on different inflorescences of the same specimen. Kuntze used the character of perulate and eperulate inflorescences for major divisions of the genus which led him to separate those forms of *C. Gouriana* with scales or leafy bracts (stipules) at the base of the inflorescence as a distinct species. The species was reduced by Finet and Gagnepain to a form of their *C. Vitalba β Cl. Gouriana*, and they cite under it Bodinier's no. 1884 which is the holotype of *C. Vitalba* var. *micrantha* Lévl. & Vant., but the specimen in the Léveillé herbarium which is rather fragmentary, shows no stipules. Leafy bracts, however, are present in Cavalerie no. 3583, referred to *C. Martini* by Léveillé (Fl. Kouy-Tchéou, 333).

Specimens of *C. Gouriana* with leafy bracts or scales at the base of the inflorescence are found occasionally, as Henry no. 4329 and Wilson no. 2397 (Veitch Exp.) from Hupeh, and Hers, nos. 848 and 1351 from Honan. Also in *C. Gouriana* var. *Finetii* Rehd. & Wils., some specimens exhibit this character, as Wilson no. 672 (type of var. *Finetii*) from Hupeh, and J. F. Rock no. 14733 from Kansu. From the specimens cited, it appears that this variation occurs in the northern part of the range of the species.

Cavalerie no. 2662 is a syntype of *C. Martini*, but there is another specimen under the same number in Herb. Léveillé, which is *C. rubifolia* Wright and was correctly referred by Léveillé to that species (Fl. Kouy-Tchéou, 333).

Clematis parviloba Gardn. & Champ. var. **ganpiniana** (Lévl. & Vant.), comb. nov.

Clematis Vitalba var. *Ganpiniana* Léveillé & Vaniot in Bull. Acad. Intern. Géog. Bot. **11**: 167 (1902).

Clematis parviloba Gardn. & Champ. var. *glabrescens* Finet & Gagnepain in Bull. Soc. Bot. France, **50**: 534 (1903); Contrib. Fl. As. Or. **1**: 19 (1905). — Léveillé, Fl. Kouy-Tchéou, 333 (1915); Cat. Pl. Yun-Nan, 222 (1917).

CHINA. K w e i c h o u : environs de Gan-pin, *L. Martin* in herb. *Bodinier*, nos. 1788, 1882 and 1883, August 10, August 4, and Sept. 4, 1897 "fleurs blanches" (syntypes of *C. Vitalba* var. *Ganpiniana;* photo. of no. 1883 in A. A.).

Clematis Vitalba var. *Ganpiniana* was first cited by Finet & Gagnepain (l.c.) as a synonym of their new variety *C. parviloba* var. *glabrescens*, without employing the earlier varietal epithet.

LARDIZABALACEAE[1]

Stauntonia Cavalerieana Gagnepain in Bull. Soc. Bot. France, **55**: 47 (1908). — Léveillé, Fl. Kouy-Tchéou, 50 (1914).

Epimedium Cavaleriei Léveillé, Cat. Pl. Yun-Nan, 18, in nota (1915); China Rev. Ann. **1916**: 18 (MS.).

CHINA. K w e i c h o u : Pin-fa, près cascade, *J. Cavalerie*, no. 1266, March 1903 (holotype of *Stauntonia Cavalerieana* in herb. Paris, ex Gagnepain; and holotype of *Epimedium Cavaleriei;* photo. in A. A.).

Stauntonia Cavalerieana and *Epimedium Cavaleriei* are both based on Cavalerie 1266, cited by Léveillé in his Fl. Kouy-Tchéou under the first name and in his Cat. Pl. Yun-Nan under the second name, but neither name appears on the type specimen in herb. Léveillé in Léveillé's handwriting. A fruiting specimen collected in Kweichou by Steward, Chiao and Cheo (no. 856) may belong here.

Stauntonia obovata Hemsley in Hooker's Ic. Pl. **29**: t. 2847 (1907).

Akebia Cavaleriei Léveillé, Fl. Kouy-Tchéou, 47 (1914). — **Synon. nov.**

Holboellia spec. Rehder in Jour. Arnold Arb. **10**: 189 (1929).

CHINA. K w e i c h o u : Pin-fa, contreforts de Yuin-ou-chan, *J. Cavalerie*, no. 955, March 28, 1903, "fleurs blanches" (holotype of *Akebia Cavaleriei;* photo. in A. A.).

When I referred in 1929 (l.c.) *Akebia Cavaleriei* Lévl. to *Holboellia*, I had only a photograph of the type with fragments consisting of detached leaflets before me, but now the loan of the type specimen enabled me to examine a flower which shows that it belongs to *Stauntonia*. *Stauntonia obovata* has so far been recorded only from Hongkong.

[1]See Vol. **10**: 189.

Holboellia coriacea Diels. — Rehder in Jour. Arnold Arb. **10:** 189 (1929).

Artabotrys Esquirolii Léveillé, Fl. Kouy-Tchéou, 29 (1914), p.p., quoad specim. Esquirol, no. 2184.

China. Kweichou: Gny-hien, bord du ruisseau, 700 m., *J. Esquirol*, no. 2184, June 1910 (syntype of *Artabotrys Esquirolii;* mero-type in A. A.).

In my note under this species (l.c.) I stated that the description does not seem to fit Esquirol's no. 2184, and that I had not seen the other syntype. I have now before me Esquirol's no. 2033, the other syntype, which agrees better with the description; this is not an *Artabotrys*, how-ever, but belongs to *Desmos cochinchinensis* Lour. (see p. 324).

Holboellia latifolia Wallich, Tent. Fl. Napal. 24, t. 16 (1824).

Hoya Cavaleriei Léveillé, Fl. Kouy-Tchéou, 42 (1914). **Synon. nov.**

China. Kweichou: Kan-pey, *J. Esquirol*, no. 322, no date, "fleurs rouges ou roses" (holotype of *Hoya Cavaleriei;* photo. in A. A.).

Esquirol's no. 322 which has 3-foliolate leaves is apparently referable to typical *H. latifolia* which has 3–5 leaflets.

BERBERIDACEAE[1]

Berberis Cavaleriei Léveillé in Fedde, Rep. Spec. Nov. **9:** 454 (1911). — Schneider in Oester. Bot. Zeitschr. **67:** 140 (1918). — Byhouwer in Jour. Arnold Arb. **9:** 133 (1928).

Berberis Griffithiana Schneider sensu Schneider in Sargent, Pl. Wilson. **1:** 364 (1913), pro parte, quoad specim. citata. — Léveillé, Fl. Kouy-Tchéou, 48 (1914). — Rehder in Jour. Arnold Arb. **10:** 189 (1929). — Handel-Mazzetti, Symb. Sin. **7:** 326 (1929). — Non Schneider (1905).

China. Kweichou: entre Kouan-chan et Kouy-yang, *J. Cavalerie*, no. 3209, Apr. 1907, "fleurs jaunes" (holotype of *B. Cava-leriei;* photo. in A. A.).

Schneider in 1913 (l.c.) referred to his *B. Griffithiana* based in 1905 on Griffith 125 from Bhutan, several Chinese specimens, and he also identified *B. Cavaleriei*, of which Léveillé had sent fragments to the Arnold Arboretum in 1916, as *B. Griffithiana;* this induced Léveillé to cite his *B. Cavaleriei* in his Fl. Kouy-Tchéou as a synonym of *B. Griffith-iana* and transfer the name to another species which turned out to be a *Gymnosporia* (see Jour. Arnold Arb. **14:** 250). In 1917, however, Schneider (in Sargent, Pl. Wilson. **3:** 438) stated that *B. Griffithiana* is entirely absent from China, and therefore, took up again in 1918 (l.c.) the name *B. Cavaleriei* Lévl. of 1911.

[1]See Vol. **10:** 189.

Berberis Julianae Schneider in Sargent, Pl. Wilson. **1:** 360 (1913); in Oester. Bot. Zeitschr. **67:** 138 (1918). — Léveillé, China, Rev. Ann. 1916, p. 18 (MS).

Berberis stenophylla "Hance" sensu Léveillé, Fl. Kouy-Tchéou, 48 (1914); non Hance, nec Lindl.

Berberis Griffithiana Schneider sensu Schneider in Sargent, Pl. Wilson. **1:** 364 (1913), p.p., quoad specim. Bodinier 2143 [= 2145]; non Schneider (1905).

CHINA. K w e i c h o u : environs de Kouy-yang, commun partout dans la mont., *E. Bodinier,* no. 2145, March 30, 1898 "fleur jaune foncé" (photo. in A. A.).

Berberis stenophylla Lévl. was referred by Léveillé in 1916 (l.c.) and by Schneider in 1918 (l.c.) to *B. Julianae,* but it differs from typical *B. Julianae* in the smaller leaves with only 3–7 pairs of teeth.

Berberis bicolor Léveillé in Fedde, Rep. Spec. Nov. **9:** 454 (1911); Fl. Kouy-Tchéou, 48 (1914). — Schneider in Oester. Bot. Zeitschr. **67:** 144 (1918).

Berberis acuminata "Franchet" sensu Schneider in Bull. Herb. Boiss. ser. *2,* **8:** 197 (1908), p.p., quoad specim. Henry 13267; non Franchet.

Berberis subacuminata Schneider in Sargent, Pl. Wilson. **1:** 363 (1913). — Léveillé, Cat. Pl. Yun-Nan, 18 (1915).

CHINA. K w e i c h o u : Ma-jo, *J. Cavalerie,* no. 3043, May, 1908, "fleurs exterieurement rouges, interieurement blanches" (holotype of *B. bicolor;* merotype in A. A.).

Mahonia elegans (Lévl.), comb. nov.

Berberis (*Mahonia*) *elegans* Léveillé in Bull. Soc. Bot. France, **51:** 289 (1904).

Mahonia Bodinieri Gagnepain in Bull. Soc. Bot. France, **55:** 86 (1908). — Schneider in Sargent, Pl. Wilson. **1:** 384 (1913). — Léveillé, Fl. Kouy-Tchéou 49 (1914); Cat. Pl. Yun-Nan, 19 (1915).

Mahonia Leveilleana Schneider in Sargent, Pl. Wilson. **1:** 385 (1913). — Léveillé, Fl. Kouy-Tchéou, 49 (1914).

Mahonia elegans Léveillé, Fl. Kouy-Tchéou, 49 (1914), pro synon. *M. Leveilleanae.*

CHINA. K w e i c h o u : environs de Gan-pin, *L. Martin* in herb. *Bodinier,* no. 2465, July 27, 1897 (syntype of *Berberis elegans;* photo. in A. A.); environs de Kouy-yang, mont du Collège, *E. Bodinier,* no. 2465 [not 2469] July 7, 1898 (syntype of *B. elegans* in herb. Lévl. and holotype of *M. Leveilleana* in herb. Mus. Vindob.; photo. in A. A.); environs de Gan-pin et Kouy-yang, *L. Martin* in herb. *Bodinier,* no. 2465, July 19, 1898 holotype of *M. Bodinieri* in herb. Paris; fragments in A. A.); environs de Tou-chan, Lao-chou-tse, *J. Cavalerie* in herb. *Bodinier,* July 19, 1897 (syntype of *B. elegans;* photo. in A. A.).

In his Flore du Kouy-Tchéou, Léveillé cites Bodinier no. 2465 under *Mahonia Bodinieri,* and Cavalerie's specimen from Tou-chan under *M. Leveilleana.* Later when at the Arnold Arboretum in 1916–19 Schneider himself referred his *M. Leveilleana* to *M. Bodinieri.* He was apparently not aware that *Berberis elegans* had been validly published and considered it a manuscript name, which he did not care to use to avoid any possible confusion with his *Berberis elegans* published in 1905; Léveillé's name published a year earlier, however, invalidates *B. elegans* Schneid. which has to receive a new name.[1] The specimen from Tou-chan differs slightly from the other two syntypes but is evidently conspecific.

Takeda in 1917 in his paper on *Mahonia* (in Notes Bot. Gard. Edinb. **6:** 238) lists *M. Bodinieri, M. Leveilleana* and *M. ganpinensis* (Lévl.) Fedde among the species he has not seen.

MENISPERMACEAE

Cocculus laurifolius DeCandolle, Prodr. **1:** 100 (1824).

Cinnamomum Esquirolii Léveillé Fl. Kouy-Tchéou, 218 (1915). — **Synon. nov.**

China. Kweichou: bois de Ta-ram, rivière de Lo-hou, *J. Esquirol,* no. 3586, March 1912, "fleurs jaunes" (syntype of *Cinnamomum Esquirolii;* merotype in A. A.); chemin de Pell-tiang, *J. Esquirol,* 3757, June 1912 (syntype of *C. Esquirolii;* ex Léveillé).

The locality cited above marks the northwestern limit of the range of this widely distributed species. There are also specimens from Kwangtung (C. L. Tso, Sun Yatsen herb. 20860) and from Fukien (H. H. Chung 7774) in this herbarium.

MAGNOLIACEAE[2]

Illicium Griffithii Hooker f. & Thomson, Fl. Ind. **1:** 74 (1855). — Hooker, Fl. Brit. Ind. **1:** 40 (1875).

Glochidion Cavaleriei Léveillé in Fedde, Rep. Spec. Nov. **12:** 183 (1913); Fl. Kouy-Tchéou, 163 (1914).

Illicium Cavaleriei (Lévl.) Léveillé in Monde Pl. ser. 2, **18:** 31 (1916); Rev. Ann. Chine, **1916:** 20, 23. — **Synon. nov.**

China. Kweichou: Pin-fa, ruisseau de La-tong, *J. Cavalerie,* no. 578, Oct. 1, 1902 (holotype of *Glochidion Cavaleriei;* photo. in A. A.).

[1] **Berberis Schneideri,** nom. nov.

Berberis sinensis var. *elegans* Franchet, Pl. Delavay. 35 (1889).

Berberis elegans (Franch.) Schneider in Bull. Herb. Boiss., ser. 2, **5:** 463 (1905); non Léveillé (1904).

China. Yunnan: near Mo-so-yn, *Delavay,* June 18, 1887, and nos. 827 and 1087.

[2] See Vol. **10:** 190.

The specimen agrees well in the shape and size of the leaves and in the comparatively short beak of the mature carpels with *I. Griffithii;* the seed is 4.5 mm. long.

ANNONACEAE[1]

Desmos cochinchinensis Loureiro, Fl. Cochinch. 352 (1790). — Merrill in Trans. Am. Phil. Soc. n. ser. **14**, pt. **2**: 160 (1935).

Artabotrys Esquirolii Léveillé, Fl. Kouy-Tchéou, 29 (1914), p.p. excl. specim. 2184. — **Synon. nov.**

CHINA. K w e i c h o u : ruisseau Sen-tse-pa, alt. 1400 m., *Esquirol* no. 2033, April 17, 1910 (syntype of *Artabotrys Esquirolii;* photo. in A. A.).

When I referred in 1929 (in Jour. Arnold Arb. **10**: 189) *Artabotrys Esquirolii* to *Holboellia coriacea* Diels, to which the other syntype, *Esquirol,* no. 2184 belongs, I had not seen *Esquirol* no. 2033 which I have now before me; it agrees with the description, except that "folia . . . ovata" and "flores . . . masculi atrorubri" seem to be based on *Esquirol* no. 2184.

LAURACEAE[2]

Determined by CAROLINE K. ALLEN

Cinnamonum Bodinieri Léveillé in Fedde, Rep. Spec. Nov. **10**: 369 (1912); Fl. Kouy-Tchéou, 218 (1914); Cat. Ill. Pl. Seu-Tchouen, 96, t. 45 (1918)MS; Rev. Ann. Chine, **1916**: 21, MS.

Cinnamonum hupehanum Gamble in Sargent, Pl. Wilson. **2**: 69 (1914). — Liou, Laurac. Chine & Indoch. 26 (1932).

CHINA. K w e i c h o u : environs de Kouy-yang, bois de la pagode de Lau-yo-chan, *E. Bodinier,* no. 2622, June 15, 1899 "arbre enorme in hauteur et grosseur" (holotype of *C. Bodinieri;* photo. in A. A.).

In his Flore du Kouy-Tchéou, and later in China Review, Léveillé mentions *Cinnamonum hupehanum* as a synonym of *C. Bodinieri.* Liou who prepared his Lauraceae of China and Indochina at the Paris Herbarium referred without citing Léveillé's name Bodinier no. 2622 in the Paris herbarium to *C. hupehanum.* This number is the type of *C. Bodinieri.*

Cinnamonum Camphora Nees & Ebermayer, Handb. Med. Pharm. Bot. **2**: 430 (1831).

Cinnamonum Taquetii Léveillé in Fedde, Rep. Spec. Nov. **10**: 370 (1912). — **Synon. nov.**

KOREA. Q u e l p a e r t : in sylvis Tolsouni rara, *E. Taquet,* no.

[1]See Vol. **10**: 191.

[2]See Vol. **10**: 192.

1344, Oct. 1908, (syntype of *C. Taquetii;* isotype in A. A.); in sylvis Taitpjeng rara, *E. Taquet,* no. 3159, July 1909 (syntype of *C. Taquetii;* isotype in A. A.).

Cinnamonum Parthenoxylon Meissner in De Candolle, Prodr. **15**[1]: 26 (1864). — Liou, Laurac. Chine & Indoch. 28 (1932).

Cinnamonum Neesianum Meissner l.c. — Léveillé Rev. Ann. Chine, **1916**: 21. MS.

Cinnamonum Cavaleriei Léveillé in Fedde, Rep. Spec. Nov. **10**: 370 (1912); Fl. Kouy-Tchéou, 218 (1914).

China. Kweichou: Pin-fa, *J. Cavalerie,* no. 1084, June 23, 1903 (holotype of *C. Cavaleriei,* photo. in A. A.); Ly-Po, *J. Cavalerie,* no. 2630, in 1899 (cited as *C. Neesianum* in Rev. Ann. Chine; photo. in A. A.).

The *Cinnamonum Parthenoxylon* of Meissner was distinguished by him from *C. Neesianum* by its odor, more conspicuous veins and veinlets and more divergent ribs. *Cinnamomum Neesianum* has long since been reduced to synonymy under *C. Parthenoxylon,* the conception of which has expanded to include these varying leaf characters. This is perhaps the best way to dispose of these species for there is not much difference, from the descriptions at least. The Cavalerie numbers cited above, agree with the description for *C. Neesianum,* but must be included under *C. Parthenoxylon.*

Cinnamonum pedunculatum Nees var. **angustifolium** Hemsley in Jour., Linn. Soc. Bot. **26**: 373 (1891). — Léveillé, Cat. Ill. Pl. Seu-Tchouen, 97 (1918) MS. — Liou, Laurac. Chine & Indoch. 37 (1932).

Cinnamonum linearifolium Lecomte in Nouv. Arch. Mus. Paris, sér. 5, **5**: 79 (1913). — Liou, Laurac. Chine & Indoch. 32 (1932). — **Synon. nov.**

China. Kweichou: sud de Lo-fou, *J. Cavalerie,* no. 3082, April 1907 (holotype of *C. linearifolium;* isotype in herb. N. Y.; photo. in A. A.). Szechuan: *E. Faber,* no. 575 (syntype of *C. pedunculatum* var. *angustifolium;* isotype in herb. N. Y.; (photo. in A. A.).

Lecomte when describing *Cinnamonum linearifolium* draws attention to the fact that it resembles *C. pedunculatum* var. *angustifolium,* but he points out the differences between the two, namely, the size and venation of the leaves, and the cross section of the petiole.

An examination of sheets of the two types discloses the differences mentioned by Lecomte, but these would seem to be differences of degree only, and not specific.

I have before me a photograph of *Laurus Heyneana* Wallich, mentioned in Wallich's Catalogue no. 2576, the locality unknown. This has

been transferred by Nees[1] to *Cinnamomum Heyneana*, and by Meissner[2] to *Cinnamomum iners* var. *subvenosum*. As far as can be judged by the photograph, the specimen is very similar to *Cinnamomum pedunculatum* var. *angustifolium*. An examination of the actual specimen would be necessary, however, before making the change in synonomy.

Alseodaphne camphorata (Lévl.) Allen, comb. nov.

Machilus camphoratus Léveillé in Fedde, Rep. Spec. Nov. **9**: 460 (1911).

Alseodaphne caudata Lecomte in Nouv. Arch. Mus. Paris, sér. 5, **5**: 97 (1913). — Liou, Laurac. Chine & Indoch. 43 (1932). — **Synon. nov.**

CHINA. Kweichou: Pin-fa, *J. Cavalerie*, no. 1002, May 1903, "petit arbre, odeur de camphre" (holotype of *Machilus camphoratus* and of *Alseodaphne caudata;* photo. in A. A.).

Léveillé in 1911 described *Machilus camphoratus* based on Cavalerie no. 1002. This apparently passed unnoticed, for three years later, Lecomte from the same number described *Alseodaphne caudata*. Examination of Léveillé's specimen shows it to be identical with *Alseodaphne caudata* Lecomte.

Machilus Cavaleriei Léveillé. — Rehder in Jour. Arnold Arb. **10**: 192 (1929). — Liou, Laurac. Chine & Indoch. 60 (1932).

This species is very different from any known *Machilus*. The leaves are dull, very prominently reticulate, and obtuse to emarginate at the tip. The inflorescence is large and open. At first glance it resembles *Beilschmiedia*, but the floral structure is typical *Machilus*. The perianth lobes are very rough gray pubescent on the outside.

Machilus longipedicellata Lecomte in Nouv. Arch. Mus. Paris, sér. 5, **5**: 101 (1913). — Handel-Mazzetti, Symb. Sin. **7**: 253 (1931). — Liou, Laurac. Chine & Indoch. 51 (1932).

To this species belongs J. Cavalerie, no. 3007, Kweichou: Majo, April 20, 1908, "fl. vert-jaune," cited by Léveillé in his Fl. Kouy-Tchéou, 221 (1914) under *M. oreophila* Hance. I have before me a photograph of the type of *M. oreophila* Hance. Cavalerie's specimen differs from this radically in leaf-shape, and somewhat in the inflorescence. The nearest species seems to be *M. longipedicellata* or one very close to it.

Machilus Rehderi Allen, spec. nov.

Arbor parva; ramuli glabri, purpureo-nigri, rugosi. Folia in superiore

[1]Nees in Wallich, Pl. As. Rar. **2**: 76 (1831).

[2]Meissner in De Candolle, Prodr. **15**[1]: 20 (1864).

parte ramulorum approximata, coriacea, lanceolata, longe acuminata acumine obtuso, basin versus attenuata, 9–12 cm. longa et 1.5–3 cm. lata, glabra, nitida, supra flavo-viridia, subtus pallidiora, costa leviter impressa, nervis utrinsecus 7–8 inconspicuis angulo 45° divergentibus, minute reticulata; petioli glabri, 1.5–2 cm. longi. Inflorescentiae paniculatae vel racemosae, 10–11 cm. longae, glabrae, in basi innovationum bracteis deciduis pallide rubro-fuscis tomentosis suffultae; pedunculi 3–5 cm. longi, graciles; pedicelli 7–13 mm. longi, glabri; flores 8–9 mm. longa; perianthium fere ad basin divisum, lobis 6, 6–7 mm. longis extus glabris demum reflexis, exterioribus lanceolatis obtusis intus glabris 2 mm. latis, interioribus intus dense pubescentibus, quam exteriora paulo brevioribus; stamina 9, circa 5 mm. longa, aequalia vel subaequalia, filamentis glabris 3.5 mm. longis, antheris introrsis oblongis 1.5 mm. longis, ea ordinis III. leviter ad basin pilosa et glandulis 2 reniformibus stipitatis 1.5–2 mm. longis instructis; staminodia ordinis IV. triangularia, auriculata, acuta, stipitata; ovarium subglobosum; stylus filamentis paulo brevior. Drupa globosa, minute apiculata, 7–8 mm. diam., glabra, basi perianthio reflexo instructa, pedicello incrassato.

China. K w e i c h o u : bois, Pin-fa, *J. Cavalerie,* no. 1741, April 5, 1904 "fl. voyantes à odeur forte, petit arbre" (type, photo. in A. A.); Pin-fa, *J. Cavalerie,* no. 2345, June 8, 1905, "petit arbre."

These two specimens are in the Léveillé herbarium as *Machilus Thunbergii* S. & Z. They are distinguished from this species by the leaf shape, inflorescence and the more evident thickening of the inflorescence in fruit. This species I am naming for Prof. A. Rehder who is completing a revision of the specimens in the Léveillé Herbarium.

Machilus Thunbergii Siebold & Zuccarini in Abh. Akad. Münch. **4:** 202 (1846).

Litsea coreana Léveillé in Fedde, Rep. Spec. Nov. **10:** 370 (1912). — **Synon. nov.**

Korea. Q u e l p a e r t : in pago Syekeni prope mare *E. Taquet,* no. 1356, July 1908 (syntype of *Litsea coreana;* isotype in A. A.); in silvis Taitpjeng, Yangkeuni et Sampangsan, Jul.–Oct. 1908–1910, *E. Taquet* nos. 1355, 3171, 4401 (syntypes of *L. coreana;* fragments in A. A.).

Nothaphoebe omeiensis Chun in Contrib. Biol. Lab. Sci. Soc. China, 1^5**:** 33 (1925); Jour. Arnold Arb. **8:** 21 (1927). — Rehder in Jour. Arnold Arb. **10:** 192 (1929). — Liou, Laurac. Chine & Indoch. 79 (1932).

Liou mentions as synonyms the same Léveillé species as cited by Rehder (l.c.).

Phoebe neurantha (Hemsl.) Gamble in Sargent, Pl. Wilson. **2**: 72 (1914). — Liou, Laurac. Chine & Indoch. 69 (1932).

Machilus neurantha Hemsley in Jour. Linn. Soc. Bot. **26**: 376 (1891).

In the Catalogue illustré et alphabètique des plantes du Seu-Tchouen, Léveillé mentions *M. neurantha* var. *ferruginea*, without citing a collector or number. The sheet, so far, has not been found in the Léveillé herbarium. It has probably been placed in another species or even in another genus.

Sassafras tzumu Hemsley in Kew Bull. Misc. Inform. **1907**: 55. — Rehder in Jour. Arnold Arb. **1**: 244 (1920).

Pseudosassafras tzumu Lecomte in Not. Syst. **2**: 269 (1912). — Liou, Laurac. Chine & Indoch. 81 (1932). — Merrill, Comment. Loureiro Fl. Cochinch. 165 (1935).

Lindera camphorata Léveillé in Fedde, Rep. Spec. Nov. **9**: 459 (1911); Fl. Kouy-Tchéou, 219 (1914). — **Synon. nov.**

CHINA. K w e i c h o u : Touan-po, district de Oui-ne, *J. Cavalerie* no. 2484, Aug. 13, 1905 "arbre rare" (holotype of *Lindera camphorata;* photo. in A. A.).

Neolitsea undulatifolia (Lévl.) Allen, comb. nov.

Litsea undulatifolia Léveillé, Fl. Kouy-Tchéou, 220 (1914).

Neolitsea spec. Rehder in Jour. Arnold Arb. **10**: 193 (1929).

Frutex glaber; rami et ramuli teretes, laeves, tenuiter striati, ramuli ultimi olivacei, rami vetustiores partim decorticantes cortice interiore rubro-brunneo. Folia in apice ramulorum congesta, subverticillata, lanceolata, 5–7 cm. longa et 1–2 cm. lata, margine undulata, apice longe acuta, basi cuneata, supra opace coeruleo-viridia, subtus pallide brunnea, costa utrinque prominente elevata, penninervia, nervis inconspicuis utrinsecus 12–15 angulo 60° divergentibus; petioli breves ad 2.5 cm. longi. Inflorescentiae umbellatae, sessiles, 6–9 mm. longae, infra foliorum verticillum ultimum spiraliter dispositae, pluribus bracteis glabris inclusae; flores numerosi, pedunculis pubescentibus circa 4 mm. longis; perianthium fere ad basin divisum, lobis 4 glabris, 2 interioribus anguste ovatis plus minusve carinatis 4 mm. longis, exterioribus late ovatis majoribus; stamina 6, 2–4 filamentis glabris satis robustis circa 2 mm. longis, basi glandulis sessilibus reniformibus instructis, stamina reliqua filamentis eglandulosis 2.5 mm. longis gracillimis, antheris oblongis introrsis 1.5 mm. longis; ovarium ellipsoideum, glabrum.

CHINA. K w e i c h o u : Tou-chan, *J. Cavalerie,* without number, March 14, 1900 "arbuste, fl. blanches, odoriferantes," (holotype of *Litsea undulatifolia,* dupl. in A. A.).

This species resembles superficially *Neolitsea confertifolia* (Hemsl.)

Merr., but can be distinguished vegetatively from it by the narrower leaves not glaucescent beneath and undulate at the margin.

As Léveillé's description is inadequate, a complete description has been given above. Léveillé states that both the leaves and the inflorescence are fasciculate.

Litsea Dunniana Léveillé in Fedde, Rep. Spec. Nov. **9:** 460 (1911); Fl. Kouy-Tchéou, 220 (1914).

Neolitsea spec. Rehder in Jour. Arnold Arb. **10:** 193 (1929).

China. Kweichou: forêts de Gam-go, *J. Esquirol,* no. 565, Dec. 15, 1905, "arbre" (type of *L. Dunniana*, photo. in A. A.).

This species has been left in *Litsea* because of the number of stamens and the type of inflorescence.

The type of *Litsea Dunniana* superficially resembles *Litsea Garrettii* Gamble var. *longistaminata* Liou.[1] The pubescence on the undersurface of the leaf of Esquirol no. 565, however, consists of long, slightly villous hairs, the inflorescence is sessile, the staminal filaments are glabrous, and the style is covered with whitish hairs. In the two syntypes of *Litsea Garrettii* var. *longistaminata,* the isotypes of which I have before me, the pubescence on the undersurface of the leaf consists of shorter, less conspicuous hairs; the inflorescence consists of umbels in a short raceme; the staminal filaments are covered with brownish hairs, and the style is glabrous.

Litsea Esquirolii (Lévl. in herb.) Allen, spec. nov.

Eurya Esquirolii Léveillé, Fl. Kouy-Tchéou 415 (1915), nomen nudum.

Neolitsea spec., Rehder in Jour. Arnold Arb. **10:** 193 (1929).

Arbor?; rami brunnei, pubescentes, ultimi ramuli dense pubescentes, vetustiores glabri. Folia in parte superiore ramulorum, lanceolato-elliptica, 6–10 cm. longa et 1.75–2.5 cm. lata, apice acuminata, ad basin sensim attenuata, supra nitida, subtus pallidiora, glaucescentia, minute pubescentia, penninervia, costa subtus pilosa manifeste elevata quam parenchyma intensius colorata, nervis utrinsecus 5–8 utrinque leviter elevatis, supra rete venularum satis distincto; petioli dense sed tenuiter pubescentes, 8–13 mm. longi. Umbellae 1–3 in axillis foliorum et saepe infra in axillis bractearum caducarum, pedunculis 2 mm. longis pubescentibus; flores plures, sessiles, circa 5 mm. longi, bracteis 4 inclusi, exterioribus brunneis leviter pubescentibus, interioribus majoribus pallide brunneis dense pubescentibus; perianthium ad 2/3 divisum, tubo inferiore parte extus densissime longe piloso, intus dense breviter pubescente, lobis 6 oblongo-lanceolatis acutis extus sparsius pubescenti-

[1]Liou, Laurac. Chine & Indoch. 196 (1932).

bus intus glabris; stamina 7–9, antheris extrorsis, 2–3 interiora filamentis 3 mm. longis sparse pilosis ad basin glandulis 2 sessilibus cordatis instructis, stamina reliqua filamentis eglandulosis paulo longioribus gracilioribus; pistillum circa 2 mm. longum ovario ovoideo, stylo curvato, stigmate conspicuo.

CHINA. K w e i c h o u : Gan chouen, *J. Esquirol,* no. 3893, 1912 (type = isotype of *Eurya Esquirolii,* nom. nud., in A. A.).

Superficially this species resembles somewhat *Litsea lancifolia* Hook. f., but the leaves of the latter are of finer texture, longer and not shining; the inflorescence consists of groups of stalked small umbels, while in *Litsea Esquirolii,* there is a single cluster of umbels to a peduncle.

There is a question of the technicality of making *Litsea Esquirolii* a new species. Léveillé in Flore du Kouy-Tchéou, has mentioned the name only. Since the first description to appear is the one given above, it has been published as a new species.

Litsea mollis Hemsley in Jour. Linn. Soc. Bot. **26:** 383 (1891). — Léveillé, Fl. Kouy-Tchéou, 220 (1914). — Liou, Laurac. Chine & Indoch. 186 (1932).

CHINA. K w e i c h o u : Touan-po, Mou-kiang-to, *J. Cavalerie,* no. 2486, August 13, 1905; "grand arbre 7 ou 8 mètres, arbre purpurié, le fruit vert de condiment" (cited in Fl. Kouy-Tchéou under *L. mollis*).

Cavalerie no. 2486, which I have before me, has been correctly identified by Léveillé. Liou recognizes *L. mollis,* but appends a note to the effect that in his opinion, *L. mollis* will eventually, when fruit is known, go into synonymy under *L. cubeba* Pers.

Litsea spec.

Lindera Esquirolii Léveillé in Fedde, Rep. Spec. Nov. **9:** 327 (1911); Fl. Kouy-Tchéou 219 (1914), as synonym of *Lindera praecox* Blume.

CHINA. K w e i c h o u : *J. Esquirol,* no. 738 (type of *Lindera Esquirolii;* photo. in A. A.).

Léveillé described Esquirol no. 738 as a new species in Fedde's Repertorium. Later, in his Flore du Kouy-Tchéou, he placed it under *Lindera praecox* Bl., along with Bodinier no. 2114, Esquirol nos. 369 and 911. Close examination of all four numbers, however, reveals the fact that they do not belong to the genus *Lindera* but to *Litsea* and are very close to *L. sericea* Hook. f. They doubtless represent a new species, but without leaf specimens and fruit, its description would be inadequate.

Benzoin commune (Hemsl.) Rehder, Jour. Arnold Arb. **1:** 144

(1919); l.c. **10:** 194 (1929). — Handel-Mazzetti, Symb. Sin. **7:** 258 (1931).

Lindera communis Hemsley in Jour. Linn. Soc. Bot. **26:** 387 (1891). — Liou, Laurac. Chine & Indoch. 130 (1932).

Lindera Bodinieri Léveillé in Fedde, Rep. Spec. Nov. **10:** 371 (1912).

China. Kweichou: Add: Pin-fa, *J. Cavalerie,* no. 798, June 25, 1902 (syntype of *L. Bodinieri;* photo. in A. A.).

There is a great variation in the amount of pubescence in this species. The only two numbers I have seen of those quoted by Hemsley as syntypes of *Lindera communis,* Henry 1296 and 3413, are sparingly and very finely pubescent on the lower leaf surface and twigs. The majority of the specimens examined from Hupeh are similar to these or more pubescent. For the most part, those collected in Yunnan have much the same characteristics. In some cases, however, the pubescence is confined only to the primary veins of the leaf. Bodinier no. 105, type of *Lindera yunnanensis* Lévl. and referred to *B. commune* by Rehder, is typical of the species. Esquirol no. 372 (type of *Litsea Esquirolii* Lévl.) and Bodinier no. 2179 (type of *Lindera Bodinieri*) placed under *B. commune* by Rehder, are both very densely pubescent.

Those numbers from the eastern provinces of China represent the other extreme, in being almost entirely glabrous on the under surface of the leaves and the twigs.

Benzoin glaucum Siebold & Zuccarini. — Rehder in Jour. Arnold Arb. **10:** 194 (1929).

Lindera glauca Blume, Mus. Bot. Lugd.-Bat. **1:** 325 (1850). — Léveillé, Fl. Kouy-Tchéou, 219 (1914).

China. Kweichou: Pin-fa, *J. Cavalerie,* no. 45, July 15, 1902; without definite locality, *J. Cavalerie,* no. 2378, "fl. verte jaune," March 26, "fr." June 15, 1905.

Cavalerie nos. 45 and 2378 which Léveillé cites are typical *B. glaucum,* but no. 1961 is an *Ilex,* apparently referable to *I. cinerea* Champ.

Benzoin touyunense (Lévl.) Rehder in Jour. Arnold Arb. **10:** 194 (1929); **11:** 158 (1930). — Handel-Mazzetti, Symb. Sin. **7:** 258 (1931).

Litsea touyunensis Léveillé in Fedde, Rep. Spec. Nov. **11:** 63 (1912); Fl. Kouy-Tchéou, 220 (1914).

Benzoin touyunense f. **megaphyllum** (Hemsl.) Rehder in Jour. Arnold Arb. **11:** 158 (1930).

Lindera megaphylla Hemsley in Jour. Linn. Soc. Bot. **26:** 389 (1891). — Léveillé, Fl. Kouy-Tchéou, 219 (1914), pro parte. — Liou, Laurac. Chine & Indoch. 124 (1932).

CHINA. K w e i c h o u : Add: Majo, Long-by, *J. Cavalerie,* no. 3053 (in part), July 1908, "assez grand arbre" (cited under *Lindera megaphylla* Brandis).

Léveillé has placed under *Lindera megaphylla* Brandis, Cavalerie no. 3053, which consists of two sheets at least. Of the two sheets which I have seen, one is *Benzoin touyunense* f. *megaphylla* (Hemsl.) Rehd., and the other is *Actinodaphne reticulata* Meissn. Cavalerie, no. 3585, cited along with no. 3053 is *Tarenna incerta* Koord. & Val. (see Jour. Arnold Arb. **16**: 321).

The author citation "Brandis" for *Lindera megaphylla* is apparently a mistake. In any case, it is Hemsley's species that Léveillé had in mind, which is a synonym of *Benzoin touyunense* f. *megaphylla.* The leaves are glabrous on the lower surface, which is the character separating the form from the species proper.

CAPPARIDACEAE[1]

Capparis cantoniensis Loureiro, Fl. Cochin. 331 (1790). — Merrill in Trans. Am. Philos. Soc. n. ser. **24**: 173 (Comm. Loureiro Fl. Cochin.) (1935).

Cudrania Bodinieri Léveillé in Fedde, Rep. Spec. Nov. **13**: 265 (1914). — **Synon. nov.**

Tanieria Bodinieri (Lévl.) Chun in Jour. Arnold Arb. **8**: 21 (1927).

CHINA. H o n g k o n g : torrent de la Baie du Télégraphe près Bethanie, *E. Bodinier,* no. 1413, Jan. 14, 1896, "grande liane épineuse" (holotype of *Cudrania Bodinieri;* photo. in A. A.).

The specimen cited above differs from typical *C. cantoniensis* in the leaves narrowed at the apex into an obtuse point, not acuminate; such leaves occur occasionally, but rarely, in other specimens, as in Y. Tsiang no. 1738 from the Lo-fou-shan, Kwangtung.

Capparis viminea Hooker f. & Thomson ex Hooker f., Fl. Brit. Ind. **1**: 179 (1875).

Ficus Marchandii Léveillé in Fedde, Rep. Spec. Nov. **12**: 533 (1913); Fl. Kouy-Tchéou, 432 (1915). — **Synon. nov.**

CHINA. K w e i c h o u : without locality, *J. Esquirol* (holotype of *Ficus Marchandii;* photo. in A. A.).

There are in this herbarium Chinese specimens referable to *C. viminea* from Hainan (McClure 9520, 20110) and from Yunnan (Henry 9124 and Schneider 3237).

This and the preceding species were identified by Dr. E. D. Merrill. *Ficus Marchandii* had been already recognized as representing appar-

[1]See Vol. **10**: 195.

ently a species of *Capparis* by Dr. Handel-Mazzetti in 1929 (Symb. Sin. **7**: 100).

SAXIFRAGACEAE[1]

Deutzia Esquirolii (Lévl.) Rehder in Jour. Arnold Arb. **14**: 202 (1933).

Deutzia lancifolia Rehder in Sargent, Pl. Wilson. **1**: 147 (1912); in Jour. Arnold Arb. **12**: 276 (1931).

When referring in 1931 (l.c.) *Styrax Esquirolii* Lévl. and *Deutzia Chaffanjoni* Lévl. as synonyms to my *D. lancifolia*, I unfortunately overlooked that *Styrax Esquirolii* had priority over *D. lancifolia*. This mistake was corrected in 1933.

HAMAMELIDACEAE[2]

Bucklandia populnea R. Brown ex Wallich, Num. List. no. 7414 (1832), nom. nud. — R. Brown ex Griffith in As. Research. **19**: 94 pl. 13, 14 (1836).

Aeschynanthus Esquirolii Léveillé in Fedde, Rep. Spec. Nov. **11**: 495 (1913); Fl. Kouy-Tchéou, 180 (1914). — **Synon. nov.**

China. Kweichou: Tchei-chou, *J. Esquirol*, no. 732, "nom chinois Ma-ty-chou" (holotype of *Aeschynanthus Esquirolii;* photo. in A. A.).

According to a note on the type specimen it was referred to *Bucklandia* by Wm. G. Craib.

Distylium chinense (Franch.) Diels in Bot. Jahrb. **29**: 380 (1900). — Handel-Mazzetti, Symb. Sin. **7**: 53, in nota (1929). — Rehder in Jour. Arnold Arb. **12**: 280 (1931).

Myrica Seguini Léveillé in Fedde, Rep. Spec. Nov. **12**: 537 (1913).

Myrica rapaneoidea Léveillé in Bull. Acad. Intern. Géog. Bot. **24**: 146 (1914); Fl. Kouy-Tchéou, 281 (1915). — **Synon. nov.**

China. Kweichou: without locality, *J. Cavalerie*, no. 3929, "arbrisseau" (holotype of *Myrica rapaneoidea* and of *M. Seguini;* photo. in A. A.).

On the label of Cavalerie's no. 3929 only the name *Myrica rapaneoidea* appears.

EUCOMMIACEAE

Eucommia ulmoides Oliver in Hooker's Ic. Pl. **20**: t.1950 (1890). — Léveillé, Fl. Kouy-Tchéou, 268 (1915) *"ulmoidea."*

Eucommia ulmoidea Oliv. var. *yunnanensis* Léveillé, Cat. Pl. Yun-Nan, 174 (1916), nom. nud.

[1]See Vol. **12**: 275.

[2]See Vol. **12**: 280.

CHINA. Kweichou: Ko-tchiang-kéou, *J. Esquirol,* no. 637, Aug. 1905 (cited in Fl. Kouy-Tchéou; fragments in A. A.). Yunnan: forêts de Long-ky, alt. 700 m., *E. E. Maire,* Aug. 1911–13 fragments in A. A.).

Eucommia ulmoidea var. *yunnanensis* was published without description and locality, but the name refers doubtless to the specimen cited above which is the only one from Yunnan in the Léveillé herbarium. I can see no difference from the typical form. The specimen may be from a cultivated tree, for it is according to Hu (cf. Icon. Pl. Sin. **1:** 26. 1927) an eastern tree, and is found in Hupeh and Szechuan only under cultivation. There is no specimen from Yunnan in the Arnold Arboretum herbarium.

ROSACEAE[1]

Neillia sinensis Oliver in Hooker's Icon. **16:** t.1540 (1886).

Neillia glandulocalyx Léveillé, Fl. Kouy-Tchéou, 348 (1915).

Neillia sinensis Oliv. f. *glanduligera* (Hemsl.) Rehder in Jour. Arnold Arb. **13:** 299 (1932).

Neillia sinensis Oliv. var. *glanduligera* Hemsl. in herb. ex Rehder l.c., pro synon., praeced.

In examining the numerous specimens of *Neillia* in this herbarium, I noticed that all flowering specimens had the calyx without glands, while in all fruiting specimens the calyx had gland-tipped setose hairs. On our cultivated plants, I was able to observe the gradual development of the glandular bristles after flowering which shows conclusively that "*glanduligera*" is not a distinct form or variety, but is descriptive of the calyx at the fruiting stage.

Spiraea Martini Lévl. — Rehder in Jour. Arnold Arb. **13:** 300 (1932). — Handel-Mazzetti, Symb. Sin. **7:** 452 (1933).

Handel-Mazzetti collected this species also in southwestern Szechuan.

Eriobotrya Cavaleriei (Lévl.) Rehder in Jour. Arnold Arb. **13:** 307 (1932). — Handel-Mazzetti, Symb. Sin. **7:** 477 (1933).

Handel-Mazzetti gives (l.c.) a complete description of the species and states that the description of the fruit is based on Wilson, Arnold Arb. Exp. no. 2993, distributed as *Pyrus Delavayi,* but in this herbarium Wilson no. 2993 is the type of *Sorbus aronioides* Rehd., and Wilson's specimen named by him *P. Delavayi* is no. 2998 and represents *Docynia rufifolia* (Lévl.) Rehd., not *Docynia Delavayi* (Fr.) Schneid.

Photinia Esquirolii (Lévl.), comb. nov.

Cotoneaster Esquirolii Léveillé, Fl. Kouy-Tchéou, 346 (1915). — Rehder in Jour. Arnold Arb. **13:** 302, in nota (1932).

[1]See Vol. **13:** 299.

China. Kweichou: bois de Ban-gnien, *J. Esquirol,* no. 2624, March 25, 1911, "couleur rosée" (holotype; photo. in A. A.).

Frutex ramulis gracilibus atrofuscis sparse et inconspicue lenticellatis initio accumbenti-pilosis mox glabris. Folia brevissime petiolata petiolo 1–2 mm. longo accumbenti-piloso vel fere glabro, lamina oblonga vel oblongo-lanceolata, 4–6.5 cm. longa et 1.1–2.5 cm. lata, medio latissima, acuminata, basi rotundata vel late cuneata, minute et inconspicue serrulata denticulis mucronulatis accumbentibus vel partim fere integra, costâ mediâ utrinque pilosâ vel fere glabrâ exceptâ glabra vel fere glabra, nervis utrinsecus 10–12 tenuibus subtus leviter elevatis. Inflorescentia circiter 5-flora, 12 mm. alta, pedicellis 5–7 mm. longis, laxe accumbenti-pilosis non verrucosis; bracteolae minutae, lineari-lanceolatae, fugaces; alabastra tantum adsunt; calyx glaber, lobis rotundatis in mucronem subito productis intus villosis; petala orbicularia; stamina circiter 20, antheris oblongis; styli ad apicem connati, stigmate capitato; ovarium apice villosum, 4-loculare.

As Léveillé's description is very brief, I have drawn up a new description as far as possible with the meagre type specimen which bears only a few flower-buds. Léveillé describes the fruit as "parvi, 5 × 5, nigricantes" but there are no fruits with the specimen and it seems unlikely that there were any, since the specimen was collected March 25.

The species seems to be most closely related to *Photinia brevipetiolata* Cardot of which I have seen no specimen. According to the description, it chiefly differs from Cardot's species in the indistinctly serrulate margin and the mostly rounded base of the leaves, in the larger inflorescence with longer pedicels and in the glabrous calyx. Cardot's species also comes from Kweichou, having been collected between Pin-fa and Kouy-yang by Cavalerie and Fortunat (no. 2607). If Léveillé's species should prove to be identical with *Ph. brevipetiolata,* the latter name would become a synonym of the new combination proposed above, since Léveillé's specific epithet has priority.

Photinia Blinii (Lévl.), comb. nov.

Cotoneaster Blinii Léveillé, Cat. Pl. Yun-Nan, 229 (1917). — Rehder in Jour. Arnold Arb. **13**: 302, in nota (1932).

China. Kweichou: Goui-reou, lit même du fleuve, alt. 600 m., *J. Esquirol,* no. 3700, Oct. 2, 1912 (holotype; photo. in A. A.).

Frutex ramulis purpureo-brunneis glabris minute sparseque lenticellatis novellis lanuginoso-tomentosis. Folia ut videtur decidua, breviter vel brevissime petiolata, lanceolata, majora circiter 3 cm. longa et 8 mm. lata, in apicem obtusiusculum minute mucronulatum attenuata, basi attenuata, integra vel indistincte crenulate, supra tomento lanugi-

noso mox evanescente, infra denso flavescente obtecta, costa supra leviter impressa subtus leviter elevata, nervis indistinctis. Flores non visi. Corymbus fructifer terminalis, 18 mm. altus, compactus, ramulis et pedicellis brevibus glabris purpureo-brunneis conspicue lenticellatis, fructibus paucis vel pluribus (1–5) ovoideis 6 mm. longis, calycis lobis triangularibus incurvis vix 1 mm. longis coronatis; ovarium triente superiore liberum, 3-loculare, semine unico evoluto ovoideo brunneo.

This plant apparently belongs to *Photinia* § Pourthiaea, as already indicated in a note on the type-sheet by Mr. W. E. Evans, but differs from all other species in the entire leaves and the one-seeded fruit; at least, in the two fruits I examined only one seed of the 3-celled ovary was developed which filled the whole ovary, the thin walls of the other two locules being pressed against the outer wall. The ovary is free from the calyx in the upper third, and there are remnants of 3 styles and of about 20 stamens. As the original description is very incomplete, a fuller description of the type specimen has been given above. As stated by the collector, the shrub grows in the river bed, and the shrubs are apparently at times wholly immersed in the water, since two of the branchlets are entirely enveloped by débris of vegetable matter such as is often carried by floods.

The development of leaves in the specimen seems abnormal, for the specimen having been collected in October with mature fruits, has no mature leaves, which were apparently destroyed and carried away by a flood. The leaves present are all young leaves, partly still unfolding which probably developed after the flood.

Rosa multiflora Thbg. var. **adenophora** Franchet & Savatier. — Rehder in Jour. Arnold Arb. **13**: 310 (1932).

Rosa Nakaiana Léveillé in Fedde, Rep. Spec. Nov. **10**: 432 (1912).

Rosa polyantha S. & Z. var. *adenochaeta* Nakai in Tokyo Bot. Mag. **40**: 569 (1926).

Boulenger (in Bull. Jard. Bot. Bruxelles, **9**: 267, 1933) refers *Rosa Nakaiana* to *R. Luciae* as *R. Luciae* var. *Nakaiana* (Lévl.), but according to the type specimen of which I have a photograph and fragments before me, the styles of *R. Nakaiana* are glabrous as described by Léveillé, which removes it at once from *R. Luciae*. Boulenger does not cite the type of *R. Nakaiana* under his variety and may not have seen it.

Rosa multiflora var. **mokanensis** (Lévl.), comb. nov.

Rosa Mokanensis Léveillé in Fedde, Rep. Spec. Nov. 7: 340 (1909). — Willmott, Gen. Rosa, **2**: 511, t. (1914).

Rosa multiflora var. *quelpaertensis* Rehder & Wilson in Sargent, Pl. Wilson. **2**: 335 (1915), quoad synon. *R. mokanensis*.

Rosa calva Bouleng. var. *mokanensis* Boulenger in Bull. Jard. Bot. Bruxelles, **9**: 270 (1933).

KOREA. Quelpaert: Mokan, *E. Taquet,* no. 778 (770 ?), June 3, 1908 (holotype of *R. Mokanensis,* in part; photo. and isotype [770] in A. A.).

Boulenger separates (in Bull. Jard. Bot. Bruxelles, **9**: 268–275. 1933) *Rosa multiflora* var. *calva* Franch. & Sav. from *R. multiflora* as a distinct species based chiefly on the glabrous pedicels of the former and refers to *R. calva* as varieties also *R. multiflora* var. *cathayensis* Rehd. & Wils. and var. *formosana* Cardot. I do not consider the character of pubescent or glabrous pedicels important enough for specific differentiation, but it may be used as a varietal character to distinguish var. *mokanensis* with glabrous pedicels from var. *quelpaertensis* with hairy pedicels.

The citation of the type of this variety represents two complications; the first is the fact that Taquet's number contains two specimens belonging to different species. However, the words "pedunculis glandulosis" of Léveillé's meagre description apply only to the left hand specimen, and the drawing published by Miss Willmott is clearly based on an identical specimen, probably sent to her by Léveillé. The right hand specimen on the sheet has perfectly smooth pedicels and a pubescent style and belongs to *R. Wichuraiana* Crép. The second complication is the question of the correct number which is cited by Léveillé as 778; this seems to be a mistake for on the label of the isotype in this herbarium, the number is clearly 770 and on Léveillé's type sheet, the last figure of the number is not at all like the "8" in 1908 of the same label. The mistake was already indicated by citing in Sargent, Pl. Wilson. **2**: 335 the number as 770 followed by "778 (ex Léveillé)."

In regard to the name *R. calva,* it may be pointed out that, as this species includes *R. Mokanensis,* the latter name being the oldest specific epithet should have been used for the group.

Rosa multiflora var. **quelpaertensis** (Lévl.) Rehder & Wilson in Sargent, Pl. Wilson. **2**: 335 (1915), and Rehder in Jour. Arnold Arb. **13**: 310 (1932), excl. synon. *R. mokanensis.* — Boulenger in Bull. Jard. Bot. Bruxelles, **9**: 274 (1933)

Rosa polyantha S. & Z. var. *quelpaertensis* Nakai in Tokyo Bot. Mag. **40**: 569 (1926), excl. synon. *R. Mokanensis.*

As stated under the preceding variety, it seems best to treat *R. mokanensis* Lévl. as a distinct variety of *R. multiflora.*

Rosa Wichuraiana Crépin. — Rehder in Jour. Arnold Arb. **13**: 311 (1932).

Rosa Luciae Fr. & Sav. var. *Wichuraiana* Koidzumi in Jour. Coll. Sci. Univ. Tokyo, **34**: 234 (1913). — Boulenger in Bull. Jard. Bot. Bruxelles **9**: 264 (1933).

Rosa Luciae var. *Taquetiana* Boulenger, l.c. 267 (1933).

Rosa mokanensis Lévl. p.p. is probably best omitted from the synonymy, since this species seems to be based exclusively on the branch referable to *R. multiflora* (see above under *R. multiflora* var. *mokanensis*). In the enumeration of specimens Taquet no. 102 should be called holotype of *R. Taquetii* rather than syntype, since the other branch on the sheet did not enter in the description. Taquet no. 5586 is the holotype of *R. Luciae* var. *Taquetiana* Boulenger and seems to be a small-leaved form of *R. Wichuraiana*.

Koidzumi (l.c.), Cardot (in Bull. Mus. Paris, **23**: 116, 1917) and Boulenger (l.c.) consider *R. Luciae* and *R. Wichuraiana* conspecific and distinguish the latter as a variety; the two species are undoubtedly closely related, but for the present I prefer to keep them distinct.

Rosa Gentiliana Léveillé & Vaniot. — Rehder & Wilson in Sargent, Pl. Wilson. **2**: 312 (1915), excl. synon. et speciminibus cit. — Rehder in Jour. Arnold Arb. **13**: 313 (1932). — Boulenger in Bull. Jard. Bot. Bruxelles, **9**: 260 (1933).

As Boulenger points out this rose is a doubtful species and belongs probably into the affinity of *R. Maximowicziana* Reg. and may be the same as *R. tsusimensis* Nakai which is unknown to me. The type specimen of *R. Gentiliana* seems to have been lost, but there exist two plates apparently drawn from the same specimen which have to serve as the type. I have seen so far no specimen which agrees with these drawings and all the material enumerated in 1915 by the writer and E. H. Wilson belong to another species described in 1933 by Boulenger as *R. Henryi*[1] which is easily distinguished from the true *R. Gentiliana* by the narrow entire stipules and the pubescent styles.

Rosa Rubus Léveillé & Vaniot. — Cardot in Bull. Mus. Paris, **23**: 116 (1917). — Rolfe in Gard. Chron. ser. 3, **68**: 59 (1920). — Täckholm in Act. Hort. Berg. **7**: 104 (1922). — Rehder in Jour. Arnold Arb. **13**: 312 (1932). — Boulenger in Bull. Jard. Bot. Bruxelles, **9**: 234 (1933). — Rehder, Man. Cult. Trees & Shrubs, 431 (1927).

Cardot considers *R. Rubus* to be only a variety of *R. moschata*, but does not make a combination nor does he reduce it to synonymy.

[1] **Rosa Henryi** Boulenger in Bull. Jard. Bot. Bruxelles, **9**: 231 (1933).
Rosa Gentiliana "Léveillé & Vaniot" sensu Rehder & Wilson in Sargent, Pl. Wilson **2**: 312 (1915), quoad synon. cit. et specimina citata. — Rehder, Man. Cult. Trees Shrubs, 432 (1927). — Handel-Mazzetti, Symb. Sin. **7**: 525 (1933). — Non Léveillé & Vaniot.
Widely distributed through eastern, central and western China.

Rosa adenoclada Léveillé. — Rehder in Jour. Arnold Arb. **13:** 314 (1932).

This rose is merely mentioned by Boulenger under *R. Henryi* (in Bull. Jard. Bot. Bruxelles, **9:** 232 (1933) as not belonging to the Synstylae; he ventures no opinion about its relationship.

Rosa longicuspis A. Bertoloni. — Rehder in Jour. Arnold Arb. **13:** 314 (1932).

Rosa Willmottiana Lévl. is considered a distinct species by Boulenger (in Bull. Jard. Bot. Bruxelles, **9:** 232 (1933). Though perhaps not sufficiently different to be regarded as a species, it may be distinguished as a variety, as I have already intimated in 1932 (l.c.).

Rosa cymosa Trattinnick, Ros. Monog. **1:** 27 (1823).

Rosa microcarpa Lindley. — Rehder in Jour. Arnold Arb. **13:** 314 (1932). — Non Retzius (1803), nec Besser (1811).

On the cover of *Rosa microcarpa* and *R. Chaffanjoni* in the Léveillé herbarium appears the name *Rosa Patrum* Lévl. This is apparently a manuscript name and I find it only in the two manuscript works by Léveillé: Rosetum universum (1917) and Catalogue illustré et alphabetique des plantes du Seu-Tchouan (1918); in the first publication it appears as "113. *R. Patrum* Lévl. nov. nom. (*microcarpa* Lindl. 1820, non Retz. 1803," in the second publication the name appears only with a reference to the Rosetum.

As *Rosa microcarpa* Lindl. is a later homonym, *Rosa cymosa* Tratt. has to take its place. Léveillé overlooked the existence of *R. cymosa* and proposed *R. Patrum* for the preoccupied name.

Rosa Davidi Crép. var. **elongata** Rehder & Wilson. — Rehder in Jour. Arnold Arb. **13:** 318 (1932).

Rosa Davidi var. *elongata* and *R. Parmentieri* Lévl. are cited by Boulenger (in Bull. Jard. Bot. Bruxelles, **13:** 252 (1935) as synonyms of *R. Davidi* Crép.

Rosa sertata Rolfe. — Rehder, l.c. (1932).

Rosa sertata Rolfe and *R. iochanensis* Lévl. are cited by Boulenger (op. cit. 193) as synonyms of *R. Webbiana* Wall.

Rosa omeiensis Rolfe. — Rehder, l.c. (1932).

Rosa omeiensis Rolfe, *R. Sorbus* Lévl. and *R. Mairei* Lévl. are cited by Boulenger (op. cit. 192) as synonyms of *R. sericea* Lindl.

Rosa Mairei Léveillé. — Rehder, op. cit. 319 (1932). — Handel-Mazzetti, Symb. Sin. **7:** 528 (1933).

Boulenger (op. cit. 192) considers *R. Mairei* a synonym of *R. sericea* Lindl.

Prunus Wilsonii (Diels ex Schneid.) Koehne var. **leiobotrys** Koehne in Sargent, Pl. Wilson. **1:** 63 (1911). — Léveillé, Fl. Kouy-Tchéou, 352 (1915).

Prunus Dunniana Léveillé in Fedde, Rep. Spec. Nov. **10:** 377 (1912).

CHINA. Kweichou: Kai-tchéou, *Cavalerie,* no. 2985, June 1908, "grande arbre" (holotype of *P. Dunniana;* photo. in A. A.).

According to a note on the type specimen, this was determined by Koehne in 1913 as *P. Wilsonii* var. *leiobotrys* and subsequently enumerated by Léveillé under that name in his Flore du Kouy-Tchéou. All the other specimens from Kweichou I have seen, as Tsiang nos. 4441, 6654, 7064 and 8870, belong to typical *P. Wilsonii* which has the rachis of the inflorescence pubescent.

(To be continued)

HERBARIUM, ARNOLD ARBORETUM,
HARVARD UNIVERSITY.

THE GENUS CESTRUM IN GUATEMALA[1]

C. V. Morton

Through the courtesy of the Arnold Arboretum I have been enabled to study a collection of Solanaceae made in Guatemala by Dr. Alexander F. Skutch, who is to be congratulated not only upon the keenness of his collecting but the excellence of his specimens as well. Inasmuch as six new species of *Cestrum* were represented in the collection, the following short synopsis of the genus in Guatemala was prepared. However, the recent appearance of a comprehensive monograph of the genus by Dr. P. Francey[2] has necessitated the rewriting of certain portions in order to include the new species described by him. One of the new species collected by Dr. Skutch has been described on other material as *C. guatemalense* Francey. No other changes have been found necessary, except that I follow Dr. Francey in referring certain specimens, which I had previously called *C. megalophyllum* Dunal, to *C. Baenitzii* Lingelsh. These two species are, admittedly, too close and should perhaps be considered only varietally distinct.

The species of Guatemala are all of restricted altitudinal range, four (*C. Baenitzii, C. panamense, C. scandens,* and *C. nocturnum*) being wide-ranging species found from sea-level up to 1000 meters altitude, rarely up to 1500 in *C. nocturnum.* Eight (*C. dumetorum, C. lanatum, C. aurantiacum, C. elegantissimum, C. Skutchii, C. Franceyi, C. cobanense,* and *C. luteovirescens*) are species of middle elevations (1000 to 2000 meters) and are, except the first two, confined to Guatemala. Five (*C. fraternum, C. formosum, C. guatemalense, C. dasyanthum,* and *C. Regelii*) are montane species, endemic in western Guatemala and Chiapas.

In addition to the material of the genus in the Arnold Arboretum and the U. S. National Herbarium, I have had also the advantage of studying the Mexican and Central American specimens in the Gray Herbarium, the loan of which is gratefully acknowledged.

[1]Published by permission of the Secretary of the Smithsonian Institution.

[2]Candollea **6**: 46–398 (1935) and **7**: 1–132 (1936).

KEY TO THE SPECIES

Stems, leaves and calyces stellate-tomentose .....3. *C. lanatum.*
Stems, leaves and calyces glabrous or hairy, the hairs sometimes branched but not stellate.
Corolla tube hairy ..... 4. *C. dasyanthum.*
Corolla tube glabrous.
Filaments appendiculate.
Corolla tube 9–11 mm. long .....5. *C. dumetorum.*
Corolla tube 15–23 mm. long.
Corolla orange; calyx lobes prominent, mucronate....
2. C. aurantiacum.
Corolla greenish-yellow, white or purplish; calyx lobes minute, deltoid or rounded.
Leaves linear or linear-lanceolate, not more than 2.6 cm. wide, usually 4 to 7 times as long; flowers sessile, borne in fascicles at the ends of short branches.
Calyx lobes deltoid; leaves linear-lanceolate ....
14. *C. luteovirescens.*
Calyx lobes low and rounded; leaves linear ..13. *C. Skutchii.*
Leaves not linear or linear-lanceolate, 3 cm. wide or more, 2–4 times as long; flowers sessile or pedicellate, borne in loose panicles.
Leaves dimorphic, those in the axils minute, orbicular, sessile and stipule-like; larger leaves glabrous, with 17–20 pairs of primary veins; calyx and rhachis purple .....12. *C. elegantissimum.*
Leaves not dimorphic, the larger with not more than 13 pairs of primary veins; calyx and rhachis green.
Filaments and appendages densely pilosulous; calyx 3.5–4 mm. long. Leaves with at least a few hairs on midrib and primary veins.
Flowers with long pedicels and short peduncles
7. C. fraternum.
Flowers with very short pedicels and long peduncles .....8. *C. Franceyi*
Filaments and appendages glabrous; calyx 3 mm. long or less.
Mature stems and petioles densely puberulous; mature leaves puberulous on the midrib beneath .....9. *C. cobanense.*
Mature stems, petioles and leaves glabrous.
Appendage of the filament deeply bipartite; inflorescences terminal, dichotomously branched, the flowers pedicellate .....
10. *C. evanidum.*

Appendage of the filament entire or merely notched; inflorescences chiefly axillary, not dichotomous, the flowers sessile .... 11. *C. nocturnum.*

Filaments exappendiculate.

Leaves hairy beneath. Montane species.

Calyx lobes long, subulate, green; corolla bright yellow 1. *C. Regelii.*

Calyx lobes short, broadly deltoid, purple; corolla yellowish, tinged with purple .....19. *C. guatemalense.*

Leaves glabrous beneath.

Corolla bright yellow; flowers relatively long-pedicellate; montane species.

Corolla tube 2–2.5 mm. broad near the middle, not over 3 times as long as the calyx, gradually enlarged upwardly .....17. *C. formosum.*

Corolla tube about 1 mm. broad near the middle, at least 5 times as long as the calyx, abruptly expanded near the summit .....18. *C. pacayense.*

Corolla pale yellowish-green; flowers sessile or subsessile, corolla tube not over 1 mm. broad near the middle, at least 5 times as long as the calyx. Lowland species.

Leaves attenuate at base, broadest above the middle 6. *C. Baenitzii.*

Leaves rounded or nearly acute at base, broadest below the middle.

Corolla small, the tube not more than 14 mm. long, the lobes 4 mm. long .....15. *C. panamense.*

Corolla large, the tube 17–20 mm. long, the lobes 7–9 mm. long .....16. *C. scandens.*

1. **Cestrum Regelii** Planchon in Fl. des Serres, 9: 229, pl. 946 (1854).

Habrothamnus aurantiacus Regel, Ind. Sem. Hort. Turic. 1850 Coll. 4. note, fide Walp. Ann. **3**: 176 (1852). Not *Cestrum aurantiacum* Lindl. (1844).

Cestrum chiapense Brandegee in Univ. Calif. Publ. Bot. **6**: 192 (1915).

Cestrum jacaltenanginum Loesener in Verh. Bot. Ver. Brandenb. **65**: 98 (1923).

Francey has attempted to maintain these three species as distinct, but the characters given to separate them seem not to hold in the material at hand. An additional species, which should perhaps have been included in the key, is *Cestrum psittacinum* Stapf (Curtis Bot. Mag. **152**: pl. 9158. 1926), founded on cultivated material of unknown origin. This is very likely a native of Guatemala, for its relationship with *C. Regelii* is close. It differs in having bicolorous corollas (the tube

orange, the lobes green), in having shorter calyx lobes, and also in having the flowers borne in non-bracteate racemes.

I have seen the following specimens of *C. Regelii*: CHIAPAS: Cerro del Boqueron, *Purpus* 7170 (type collection of *C. chiapense*). GUATEMALA: Plains near Tecpam, Chimaltenango, *Skutch* 488. Jacaltenango, Huehuetenango, *Seler* 2641 (type collection of *C. jacaltenanginum*).

2. **Cestrum aurantiacum** Lindley in Bot. Reg. **30**: Misc. 71 (1844).
Cestrum chaculanum Loesener in Verh. Bot. Ver. Brandenb. **65**: 97 (1923).
Cestrum paucinervium Francey in Candollea, **6**: 101 (1935). — **Synon. nov.**
Cestrum aurantiacum var. *chaculanum* Francey in op. cit. 104. — **Synon. nov.**

Francey has recognized several varieties of *C. aurantiacum*, as well as a new species (*C. paucinervium*) of this alliance. Of the latter I have examined a specimen of the type collection, and have not been able to separate it from typical *C. aurantiacum* either by leaves or inflorescence. The varieties are based on the size of leaves, petioles, and calyces. These differences seem artificial; but when the relative length of calyx and corolla is used as a means of separation, all the Guatemalan specimens are seen to have the corolla three times the length of the calyx or more. On the other hand, all the Costa Rican specimens have a corolla not more than twice as long as the calyx. This consistency in such an important character, coupled with the geographic separation of the two, shows that Klotzsch was very likely correct in considering that the Costa Rican plants represent a distinct species, *Cestrum Warscewiczii*.

In Guatemala *Cestrum aurantiacum* is a common species of middle elevations from 1300 to 2000 meters. The berries (not seen by Francey) are white, ellipsoidal, and very large. I have seen the following specimens from Guatemala, not cited by Francey: Coban, *Tuerckheim* 26a, 8433. Guatemala, *Tonduz* 625; *Hayes* s. n. Santa Rosa, *Cook & Doyle* 232. Santa Maria, *Kellerman* 5579. Volcán Fuego, *Donnell Smith* 2678. Without locality, *Heyde* 95. Santa María de Jesus Nepto, Quetzaltenango, *Skutch* 893.

3. **Cestrum lanatum** Martens & Galeotti in Bull. Acad. Brux. **12**[2]: 146 (1845).

A distinctive species, found in Guatemala at elevations of 1200 to 1500 meters.

4. **Cestrum dasyanthum** Donnell Smith in Bot. Gaz. **23**: 11 (1897).

A species of apparently restricted range. I have examined the following collections: Between San Martín and Todos Santos, Huehuetenango, *Nelson* 3622 (type); *Seler* 2632. San Juan Atitlán, Huehuetenango, *Skutch* 1157, 1178.

5. **Cestrum dumetorum** Schlechtendal in Linnaea, 7: 61 (1832).

A widely dispersed species, found in southern Guatemala in the Departments of Guatemala, Santa Rosa, and Amatitlán, at altitudes of 1000 to 1500 meters.

6. **Cestrum Baenitzii** Lingelsheim in Fedde, Rep. Spec. Nov. 7: 248 (1909).

Following Hemsley, the specimens cited below have previously been identified as *Cestrum macrophyllum* Vent., but that species has appendiculate filaments and is more closely allied to *C. laurifolium*. In Guatemala *C. Baenitzii* is found only near sea-level in the eastern part. The following collections have been studied. Quiriguá, Izabal, *Standley* 24481, 24533. Cubilquitz, Alta Verapaz, *Tuerckheim* 8558. Finca Sepacuité, Alta Verapaz, *Cook & Griggs* 845.

7. **Cestrum fraternum** Morton, sp. nov.

Frutex 2.4 m. altus; rami teretes, juniores puberuli, mox glabri; petioli 2.2 cm. longi, glabri; lamina foliorum elliptica, usque ad 16.5 cm. longa et 5.5 cm. lata, membranacea, apice acuminata, basi acuta vel obtusa, supra glabra, subtus costa et venis primariis parce puberula, venis primariis 10–13-jugis; inflorescentiae terminales et axillares, rhachibus gracilibus puberulis, bracteis minutis caducis, pedicellis ca. 3 mm. longis; calycis tubus viridis, campanulatus, ca. 3.5 mm. longus et 2 mm. latus, glaber, lobis minutis late deltoideis plus minusve mucronatis ca. 0.5 mm. longis margine puberulis; corollae tubus pallide flavidus, interdum externe purpureo-tinctus, glaber, ca. 20 mm. longus, basi ca. 1.8 mm. latus, sursum sensim ampliatus sed non inflatus, fauce non contractus, ca. 5 mm. diam., lobis reflexis late ovatis, ca. 4 mm. longis et 3 mm. basi latis apice longe mucronatis; filamentorum pars libera ca. 3.5 mm. longa, glabra, basi appendiculata appendicula minuta rotundata pilosula, filamentorum pars adnata pilosula; stylus 18 mm. longus, paullo exsertus; fructus ignotus.

Type in the U. S. National Herbarium, no. 1,642,529, collected in moist thicket at Nebaj, Dept. of Quiché, Guatemala, altitude 2340 meters, Nov. 16, 1934, by A. F. Skutch, no. 1682 (isotype in Herb. Arnold Arb.).

8. **Cestrum Franceyi** Morton, nom. nov.

Cestrum pedunculatum Francey in Candollea, **7**: 66 (1936). Not Sessé & Mocino (1894).

I have seen no material of this species other than two sheets of the type collection, *Tuerckheim* 833, from Pansamala.

9. **Cestrum cobanense** Francey in Candollea, **6**: 372 (1935).

I have examined two sheets of the type collection (*Tuerckheim* II. 2372) and find this to be a well-marked species.

10. **Cestrum evanidum** Morton, sp. nov.

Frutex gracilis; rami teretes, juniores puberuli, mox glabri; petioli usque ad 1.4 cm. longi, glabri; folia juniora utrinque puberula, mox glabrata; lamina ovato-lanceolata, usque ad 13 cm. longa et 5 cm. lata, membranacea, apice acuminata, basi rotundata, venis secundariis 6–10-jugis; inflorescentia terminalis, pedunculata, dichotome ramosa, rhachibus gracilibus, glabris, viridibus, ebracteatis; calyx viridis, campanulatus, minimus, ca. 2 mm. longus, glaber, 5-costatus, basi plus minusve longe stipitato-pedicellatus, lobis parvis deltoideis aequalibus; corolla viridis, glabra, tubo angusto 20–23 mm. longo basi ca. 0.6 mm. lato sursum sensim ampliato et usque ad 3 mm. lato, fauce non contracto, lobis lanceolatis ca. 5 mm. longis; filamenta recta, glabra, appendiculata, appendicula magna bipartita glabra.

Type in the U. S. National Herbarium, no. 1,642,528, collected at Finca Moca, Dept. Suchitepequez, Guatemala, alt. 960 meters, Jan. 7, 1935, by A. F. Skutch, no. 2071A (isotype in Herb. Arnold Arb.).

The following specimen, distributed as *Cestrum nocturnum*, is also referred to *C. evanidum*: Acatepeque, Dept. Zacatepequez, Guatemala, alt. 1290 meters, *Donnell Smith* 2681.

The closest relationship of *Cestrum evanidum* is perhaps with *C. nocturnum*, a species which, in spite of its wide range, is relatively constant in appearance and essential characters. The inflorescences of *C. nocturnum* are chiefly axillary, are not dichotomous, and are usually without an obvious peduncle, characters which easily distinguish that species from *C. evanidum*, which has strictly terminal, dichotomously branched, pedunculate inflorescences. The calyx of the latter is obviously 5-ribbed and rather long-stipitate at base, but that of *C. nocturnum* is ribless and usually almost sessile. The filament appendages of *C. nocturnum* are sometimes inconspicuously notched, but are never deeply partite into two subulate lobes as in *C. evanidum*.

11. **Cestrum nocturnum** Linné, Sp. Pl. 191 (1753).

A common lowland species occurring from sea-level up to 1500 meters elevation.

12. **Cestrum elegantissimum** Morton, sp. nov.

Frutex 3.6 m. altus; rami teretes, glabri; folia dimorpha; petioli usque ad 1.2 cm. longi, glabri, supra canaliculati; lamina foliorum majorum oblongo-lanceolata, usque ad 16 cm. longa et 5 cm. lata, papyracea, apice longe et acriter acuminata, basi acuta vel obtusa vel rotundata, glabra, venis primariis utrinque elevatis 17–20-jugis ex costa angulo fere 90° egredientibus subrectis marginem versus furcatis, ramulis alteris utroque latere conjunctis; folia minora axillaria minuta, auriculiformia, stipuliformia, orbicularia, usque ad 1 cm. longa, petiolo nullo; inflorescentia terminalis, usque ad 13 cm. longa et 11 cm. lata, paniculata, ramulis infimis basi foliis auriculiformibus suffultis, rhachibus atropurpureis gracilibus puberulis, pilis hyalinis numerosis multiseptatis flaccidis interdum fortasse glanduliferis, bracteis atropurpureis linearibus vel lineari-subulatis parce puberulis plus minusve persistentibus, pedicellis brevibus 1–1.5 mm. longis crassiusculis parce puberulis; calyx atropurpureus, tubo cum pedicello continuo poculiformi ca. 2.5 mm. longo et 2 mm. lato extus pilos paucos gerente, lobis 5 regularibus deltoideis minutis ca. 0.8 mm. longis acuminatis margine dense puberulis; corolla flavescenti-viridis, haud purpurascens, tubo glabro ca. 21 mm. longo anguste tubuloso basi recto ca. 1.5 mm. lato, faucem versus paullo inflato ca. 2.5 mm. lato, fauce contracto ca. 2 mm. lato glabro, lobis patulis lanceolatis ca. 6 mm. longis et ca. 2 mm. latis acutis marginibus introflexis albis externe puberulis; filamenta (pars libera) 3 mm. longa, glabra, basi perspicue appendiculata appendiculis obtusis vix pilosulis, filamentorum parte adnata pilos paucos gerente; ovarium glabrum, perspicue stipitatum; stylus 18.5 mm. longus, glaber, sursum granuliferus; baccae non suppetunt.

Type in the U. S. National Herbarium, no. 1,642,527, collected in forest at Finca Moca, Dept. of Suchitepequez, Guatemala, altitude 1320 meters, Jan. 7, 1935, by A. F. Skutch, no. 2071 (isotype in Herb. Arnold Arb.).

13. **Cestrum Skutchii** Morton, sp. nov.

Frutex 1.5 mm. altus; rami teretes, glabri; petioli usque ad 1 cm. longi, glabri; lamina foliorum linearis, usque ad 16 cm. longa et 2.6 cm. lata, membranacea, apice longe acuminata, basi acuta vel obtusa, glabra, venis primariis 15–20-jugis, marginem versus anastomosantibus, utrinque paullo elevatis; inflorescentiae axillares (et terminales?), densae, subspicatae, 3–9-florae, rhachibus atropurpureis glabris crassiusculis, bracteis atropurpureis linearibus fere glabris, pedicellis obsoletis ca. 0.5 mm. longis glabris; calycis tubus atropurpureus, tubulosus, 3.4–5 mm. longus, 2.25 mm. latus, glaber, lobis minutis rotundatis 0.4

mm. longis margine puberulis; corollae tubus albus, plus minusve purpureo-tinctus, glaber, 21 mm. longus, anguste tubulosus, basi ca. 1.5 mm. latus, sursum gradatim ampliatus sed non ventricosus, fauce non contractus, ca. 3.75 mm. latus, lobis albis vix purpureo-tinctis recurvatis late ovatis ca. 5 mm. longis et 3.75 mm. latis, margine introflexo latissimo externe puberulo; filamentorum pars libera 4 mm. longa, glabra, basi perspicue appendiculata appendiculis obtusis pilosulis, pars adnata pilosula; ovarium glabrum, stipitatum; stylus ca. 1.9 cm. longus; baccae non suppetunt.

Type in the U. S. National Herbarium, no. 1,642,526, collected in second growth thicket on the Volcán Zunil, Dept. of Quezaltenango, Guatemala, alt. 1710 meters, Aug. 8, 1934, by A. F. Skutch, no. 988 (isotype in Herb. Arnold Arb.).

14. **Cestrum luteovirescens** Francey in Candollea, **6:** 349 (1935).

I have studied three specimens of the type collection, *Donnell Smith* 2679 from Capetillo.

15. **Cestrum panamense** Standley in Jour. Wash. Acad. **15:** 460 (1925).

Cestrum racemosum var. *panamense* Francey in Candollea, **6:** 274 (1935).

I am inclined to treat the present species as valid, in spite of its reduction by Francey to a variety of the Peruvian *C. racemosum*. In addition to the characters by which Francey separates the two, it may be pointed out that *C. racemosum* is a shrub only about a meter high, and that *C. panamense* is always a tree and often a very large one, up to 24 meters high, with a trunk three-fourths of a meter in diameter.

I have seen the following collections: Colomba, Dept. Quetzaltenango, *Skutch* 2000, 2024. Uaxactun, Petén, *Bartlett* 12175, 12743. Quiriguá, Izabal, *Standley* 23767, 24144. San Carlos, *Rojas* 207. Telemán, Alta Verapaz, *Donnell Smith* 1672. Near Patalul, *Kellerman* 5821.

16. **Cestrum scandens** Vahl, Eclog. Amer. **1:** 24 (1796).

Cestrum perilambanon Loesener in Verh. Bot. Ver. Brandenb. **65:** 98 (1923).

I have seen two collections from Guatemala: Chiquimula, altitude 165 meters, *Seler* 3381 (type collection of *C. perilambanon*). Cuyuta, Dept. Escuintla, 60 meters altitude, *Donnell Smith* 2081.

17. **Cestrum formosum** Morton, sp. nov.

Frutex gracilis, erectus, 4.5 m. altus; rami teretes, glabri; petioli satis longi, 17–23 mm. longi; lamina foliorum elliptica, usque ad 9 cm. longa

et 3.5 cm. lata, papyracea, apice acuminata, basi acuta vel obtusa, plerumque obliqua, utrinque glabra, venis primariis 9–11-jugis prominulis; inflorescentiae terminales et axillares, laxae, pauciflorae, pedunculatae, pedunculo usque ad 1.8 cm. longo, rhachibus glabris, bracteis linearibus glabris, pedicellis 4–5 mm. longis; calycis tubus viridis, campanulatus vel subturbinatus, ca. 4.5 mm. longus, 3.5 mm. latus, glaber, lobis minutissimis vix 0.25 mm. longis costa percurrente; corollae tubus luteus, glaber, crassiusculus, ca. 14 mm. longus, basi 2.5 mm. latus, sursum sensim ampliatus sed non inflatus, fauce non contractus, hic ca. 4.5 mm. latus, lobis patulis vel recurvatis crassis late ovatis ca. 4.5 mm. longis et 3.5 mm. basi latis apice mucronatis; filamentorum pars libera brevis, ca. 2 mm. longa, glabra, exappendiculata, pars adnata pilosula; stylus crassus, 12 mm. longus, paullo exsertus; fructus ignotus.

Type in the U. S. National Herbarium, no. 1,642,530, collected in bushy growth on the south slope of Volcán Atitlán, Dept. of Suchitepequez, Guatemala, altitude 2400 meters, Jan. 14, 1936, by A. F. Skutch, no. 2143 (isotype in Herb. Arnold Arb.

18. **Cestrum pacayense** Francey in Candollea, 6: 90 (1935).

Cestrum Kellermanii Francey in op. cit. 89. — **Synon. nov.**

I do not find any significant points of difference between these two species, the types of which have kindly been lent to me by the Field Museum. In leaf characters *C. pacayense* is almost identical with *C. formosum*, but the floral structure is different.

19. **Cestrum guatemalense** Francey in Candollea, 6: 98 (1935).

I believe that the present species must be referred to the section EUCESTRUM, as neither by calyx nor corolla does it correspond with the definition of the section HABROTHAMNUS, in which it is placed by Francey. The Skutch specimens cited below had been identified by me as a new species and distributed under a manuscript name. I have seen the following specimens: Hacienda Chaucol, alt. 3300 meters, *Nelson* 3645, 3666 bis (type collection). Chichavac, Chimaltenango, alt. 2490 meters, *Skutch* 27 and 754.

19a. **Cestrum guatemalense** var. **gracile** Morton, var. nov.

A var. *typica* calycis tubo puberulo, corollae tubo graciliore longiore (20 mm.) differt.

Type in the U. S. National Herbarium, no. 1,335,349, collected at Calél, Dept. Totonicapám, Guatemala, alt. 2550 meters, Nov. 1891, by W. C. Shannon (*Donnell Smith* no. 282).

UNITED STATES NATIONAL HERBARIUM,
SMITHSONIAN INSTITUTION, WASHINGTON, D. C.

A NEW SPECIES OF ACER FROM GUATEMALA

ALFRED REHDER

Acer Skutchii, sp. nov.

Arbor ad 20-metralis, trunco 75 cm. diam., ramulis maturis glabris; gemma terminalis ovoidea, 4 mm. longa, perularum paribus 5–6, superioribus fulvo-villosulis, inferioribus glabrescentibus. Folia fere ad medium palmato-5-loba, 12–16 cm. longa, 14–20 lata, basi cordata sinu clauso lobis sese tegentibus, lobis triangulari-ovatis acuminatis, medio lateralibus paullo majore, leviter sinuato-lobulatis lobulis utrinque plerumque 2 rotundatis raro acutiusculis, lobis basalibus brevissimis acutis, supra glabra, subtus glauca, nervis primariis et secondariis elevatis dense villoso-tomentosis, in facie sparse lanuginoso-villosa, reticulata; petioli 2.5–11 cm. longi, dense villoso-tomentosi. Flores non visi. Inflorescentia fructifera corymbosa valde ramosa, glabra, pedicellis ad 3 cm. longis; fructus alis ascendentibus angulo angusto divertigentibus, loculis circa 1 cm. longis 7–8 mm. diam. vix complanatis lateraliter obtusissime costatis laevibus supra et subtus leviter carinatis, alis 3.5–4.5 cm. longis et 1.2–1.4 cm. latis.

GUATEMALA. Dept. of Quiche: Nebaj, beside stream in open, alt. 6200 ft., *A. F. Skutch,* no. 1667, Nov. 15, 1934, "tree to 60 ft., diam. of trunk 30 in., leaves turning bright red and falling" (type in Herb. Arnold Arb.).

This new species is closely related to *Acer nigrum* Michx. f. and *A. saccharum* Marsh. and in its pubescence resembles *A. saccharum* var. *Schneckii* Rehd., but is easily distinguished by the large leaves deeply cordate at the base with closed sinus; in the latter character it agrees with *A. nigrum,* but the pubescence in *A. nigrum* is pilose, not villous-tomentose, and the under side of the leaves is green. From both species *A. Skutchii* differs in its much larger fruits with smooth, not reticulate, nutlets which are compressed from above and almost as broad as high, not laterally compressed with evenly rounded surfaces on both sides; the wings are up to 4.5 cm. long and to 1.4 cm. broad, while in *A. saccharum* and *A. nigrum* they are 1.5–3 cm. long and 0.6–1 cm. broad. There may be other differences in the flowers which are yet unknown.

At first I was uncertain whether this maple might not better be considered a variety of *A. saccharum*, since the differences are not of great morphological value, but its general appearance is strikingly different from the sugar maple, particularly in the thick, large and smooth nutlets which distinguish it at once; it is also geographically well separated, for *A. saccharum* ranges south only to eastern Texas, and is not found in Mexico at all.

HERBARIUM, ARNOLD ARBORETUM,
HARVARD UNIVERSITY.

POLYPLOIDY AND GEOGRAPHIC DISTRIBUTION IN SPIRAEA

KARL SAX

THE GENUS *Spiraea* is widely distributed in both the Old and New Worlds, although the center of distribution appears to be in Asia, where the genus is best represented. Polyploidy — both autopolyploidy and allopolyploidy — is a common feature in other members of the Rosaceae, and *Spiraea* is no exception in this respect. Many species appear to cross readily, which adds to the complexity of the genus.

Some cytological work has been done with *Spiraea* in connection with chromosome relationships in the Rosaceae and especially in relation to the origin of the Pomoideae (Sax 1932). The genus is not favorable for cytological work; the anthers are very small at the time of meiosis, the chromosomes are small and are differentiated from cytoplasmic inclusions with difficulty. The flowering period for the genus extends from April to July, so that collections must be made over a period of several months.

Chromosome counts were determined from aceto-carmine smear preparations. Pollen fertility was determined for various species and species hybrids, and the date of flowering was recorded. The basic chromosome number is 9, and not 8, as previously reported. In many cases it was difficult to determine the exact number of chromosomes, especially in some of the polyploids and species hybrids. The data obtained from the various species are recorded in Table I.

Most of the species of the first section of the genus are diploids with 9 pairs of chromosomes at meiosis. The two exceptions appear to be autopolyploids. *Spiraea myrtilloides*, a hexaploid, is similar to *S. gemmata*, and may be an autopolyploid form of the latter species, even though it is somewhat smaller. The other exception is clearly an autopolyploid of *S. chamaedryfolia*, giving rise to the variety *ulmifolia*. The variety is larger and has a greater distribution than the type, and tends to reproduce vegetatively by suckers. All species examined in the section Chamaedryon are relatively fertile. All are natives of the Old World and all are early-flowering.

Only three species in the section Calospira were studied. *Spiraea Miyabei* is an early-flowering diploid but is relatively sterile. Both the

TABLE I

SPECIES OF SPIRAEA

Species	Chromosome number	Pollen fertility	Date of flowering	Habitat
Sect. I				
prunifolia	2n	96%	May 1	O[1]
Thunbergii	2n	80%	May 1	O
hypericifolia	2n	70%	May 8	O
nippońica	2n	95%	May 28	O
gemmata	2n	94%	May 13	O
mollifolia	2n	81%	May 13	O
myrtilloides	6n	85%	May 20	O
cana	2n	97%	May 25	O
media	2n	60%	May 20	O
chamaedryfolia	2n	86%	May 13	O
– *ulmifolia*	4n	80%	May 20	O
pubescens	2n	75%	May 20	O
Sect. II				
Miyabei	2n	8%	May 1	O
japonica	2n	98%	June 26	O
corymbosa	3n	0	June 15	N[2]
Sect. III				
salicifolia	4n	1%	July 2	O
alba	4n	99%	July 7	N
latifolia	4n	95%	July 2	N
Douglasii	4n	95%	July 2	N

good and imperfect pollen grains remain in tetrads at the time of flowering. Sterility appears to be caused by some general physiological factor, because there is little irregularity in meiosis, and all pollen grains in a given tetrad are either good or imperfect. This sterility can not be attributed to chromosome irregularities or to segregation of genetic factors. *Spiraea japonica* is the only late-flowering species which is known to be a diploid. The American species, *S. corymbosa,* is a triploid with complete pollen sterility. It must form viable egg cells or exist in a fertile diploid form, because it is involved in certain species hybrids.

[1]Old World.

[2]New World.

All the species listed in the section Spiraria are tetraploids. These are late-blooming forms and, with the exception of *S. salicifolia*, they are highly fertile. Most of the species in this section are natives of North America. Two other American species, *S. Menziesii* and *S. tomentosa*, were available in the Arnold Arboretum, but we were unable to obtain chromosome counts. The flowers, at the time of meiosis, are very small, and the anthers are minute.

There are many species hybrids of *Spiraea* which have originated in nature or in cultivation. The chromosome number and pollen fertility have been determined for nine of these hybrids (Table II).

TABLE II

SPIRAEA SPECIES HYBRIDS

Hybrid	Chromosome number	Pollen fertility	Parent Habitat
pikoviensis (*crenata* × *media*)	4n	94%	O×O
inflexa (*crenata* × *cana*)	2n	95%	O×O
pachystachys (*corymbosa* × *Douglasii*)	3n	5%	N×N
blanda (*chinensis* × *cantonensis*)	2n	42%	O×O
Billiardii (*Douglasii* × *salicifolia*)	5 or 6n	1%	O×N
notha (*corymbosa* × *latifolia*)	4n	13%	N×N
Margaritae (*japonica* × (*albiflora* × *corymbosa*))	2 and 4n	0	O×N
cinerea superhypericifolia (*hypericifolia* × *cana*)	2n	65%	O×O
intermedia (*albiflora* × *Douglasii*)	4n	0	O×N

Two of the species hybrids, *S. pikoviensis* and *S. inflexa*, are highly fertile, and both involve Old World species in the first section of the genus. The parental species, *S. media* and *S. cana*, are known to be diploids, and since the hybrid, *S. inflexa*, is a diploid, the species *S. crenata* probably is a diploid. The hybrid *S. pikoviensis* is a tetraploid, apparently of allopolyploid origin.

Crosses between species in the first section also produce hybrids which are partially sterile. *Spiraea blanda* is a cross between the diploid species *S. chinensis* and *S. cantoniensis*. There is some irregularity in chromosome pairing at meiosis, and less than half of the pollen is good. The hybrid *S. cinerea superhypericifolia* is a hybrid segregate showing about 65 per cent fertility.

Several hybrids, *S. pachystachys*, *S. Billiardii*, *S. notha*, and *S. Margaritae*, are derived from either *S. corymbosa* or *S. salicifolia* as one of the parents. These two species, as represented in our collection, have little or no perfect pollen, and must have viable egg cells or include strains

which are more normal in fertility, in order to hybridize. The hybrids involving these parental species are highly sterile, even when both parents belong to the same section. It seems probable that the pollen-sterile parents have some viable egg cells but carry genetic factors for pollen sterility.

The hybrid *S. Billiardii* was produced by crossing two tetraploids, but the hybrid has more than 4n chromosomes and probably is a hexaploid. Apparently unreduced gametes were produced by one of the parental species. Confirmation of such behavior in *Spiraea* is found in the hybrid *S. Margaritae*, a backcross involving three species. In this hybrid both diploid and tetraploid pollen mother cells were observed in flowers from the same plant, but the divisions were somewhat irregular, and no good pollen was formed. In several species there were occasional microsporocytes with twice the normal chromosome number. Whether these were isolated tetraploid areas or the result of asynapsis could not be determined.

The relations between geographic distribution, polyploidy, and time of flowering are very marked in *Spiraea*. Most of the Old World species are early-flowering diploids, while all American species are late-flowering; and of those examined cytologically, all are tetraploids. Tetraploidy alone is not responsible for the delay in time of flowering, because the tetraploid variety of *S. chamaedryfolia* is little later than the diploid parent, and the only hexaploid species found is relatively early in flowering. In general, however, the polyploid forms in most genera flower later and over a longer period than the diploids (Müntzing 1936).

The greater vigor, hardiness, and adaptability of polyploids result in the extension of the range of certain genera (Tischler 1935, Müntzing 1936, Anderson and Sax 1936). The polyploids are more frequently found at the periphery of the range. In those genera of Old World origin which are also represented in North America, one might expect a greater proportion of polyploids in the New World. Such a relation is found in *Spiraea* and in certain other genera of the Rosaceae. In *Malus*, for example, most of the oriental species are diploids, while most of the American species are tetraploids. The oriental species flower earlier than the native species and, in the Arnold Arboretum, the flowering periods of the two groups do not overlap. There is somewhat more polyploidy in the native American species of *Rosa* than in the Old World forms, but in *Prunus* there seems to be no such relationship. A comparison of species in certain genera may not be reliable because so many species used for cytological work have been in cultivation for

many generations, and selection in cultivated forms is more likely to perpetuate polyploid variants (Anderson and Sax 1936). Most of the spiraeas in our collection are of recent introduction, and with the exception of some of the hybrids, their behavior should be comparable with those found in nature. Although there is a rather striking relationship between polyploidy, time of flowering, and geographic distribution in *Spiraea* and *Malus*, there are many genera of Asiatic origin which show no such relationships between the Old and New World species.

SUMMARY

The basic chromosome number for *Spiraea* is 9. Most of the Old World species are early-flowering diploids, while the American species studied are late-flowering tetraploids. Most species are relatively fertile, but several have little or no good pollen.

A few of the species hybrids are fertile, but most show a high degree of pollen sterility. Both allo- and autopolyploids are found in the genus.

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Cytological Laboratory,
Arnold Arboretum, Harvard University.

THE ARNOLD ARBORETUM DURING THE FISCAL YEAR ENDED JUNE 30, 1936

STAFF CHANGES have been as follows. Professor Oakes Ames, Supervisor, having requested to be relieved of his multifarious administrative duties, was appointed by the University as Research Professor of Botany. He continued as Supervisor of the Arnold Arboretum until October 17, 1935 when I took over his duties as Acting Supervisor in addition to my general task as Administrator of Botanical Collections of Harvard University. The position of Administrator of Botanical Collections was created to further the task of coördination of the botanical activities, so admirably developed by Professor Ames, of the eight separately endowed units of Harvard University. These units are the Botanic Garden, the Gray Herbarium, the Botanical Museum, the Farlow Library and Herbarium in Cambridge, the Arnold Arboretum and the Bussey Institution in Jamaica Plain, the Harvard Forest at Petersham, and the Atkins Institution of the Arnold Arboretum at Soledad, Cienfuegos, Cuba.

Professor John George Jack became Assistant Professor of Dendrology, Emeritus, at the close of last year, while Dr. Donald Wyman was appointed as Horticulturist, effective January 1, 1936, succeeding Dr. Edgar Anderson, Arborist, who resigned at the end of the year to accept an appointment at Washington University, St. Louis. Associate Professor Karl Sax was promoted to full Professorship.

The Arboretum has continued to receive current gifts in support of its work from various interested individuals, while some additions have been made to the endowment. Perhaps the most important single gift was the Butler estate adjoining the Arboretum on Centre Street side. This was bequeathed to the Arboretum by Miss Isabel Butler and became available May 15th. It adds about 1½ acres to the Arboretum lands, and makes available one more dwelling house which has been designated as the official residence of the Supervisor.

Buildings and Grounds.—The winter of 1935–36 was much milder than the two preceding years. Although fairly low temperatures prevailed at times, no severe cold was experienced until after the middle of February, the lowest temperature of the winter being 13° below on February thirtieth. Light snow fell occasionally up to January nine-

teenth when the first heavy fall of snow, measuring one foot, occurred. This snowfall remained on the ground for several weeks, giving adequate protection to low-growing plants. Although the rainfall was very light from August to December there was no great injury to the plants from this cause. This limited rainfall was compensated by the snow in January, which was equivalent to over 8 inches of rain. Early spring rains were heavy in March and April, thus supplying sufficient moisture for general needs. Winter damage to trees and shrubs was no greater than during an average winter.

During the year, 1390 packages of seed were distributed, 1025 in the United States, 361 to 15 foreign countries; scions and cuttings of 899 species and varieties were supplied to institutions and individuals. There were received from various sources 334 packages of seed, 1351 living plants, and 121 cuttings and scions. Seven hundred and eighty-nine plants were added to various collections in the Arboretum.

Normal repairs to buildings were made as needed, and in the grounds various trees past their prime were removed. A vigorous spraying campaign was prosecuted to combat various insect pests and plant diseases.

Through the coöperation of the Park Department of the City of Boston, 300 feet of new wire fence was installed along the Nervine border to replace obsolete sections, and the fencing on both sides of the Jamaica Plain entrance, 150 feet, was completed, a much needed improvement. All boundary fences were painted. Roads, paths and benches were repaired and much attention was given to the problem of draining the bog opposite the Administration Building.

Pathological Laboratory.—The policy of exerting all possible efforts in furtherance of the campaign to stamp out the Dutch elm disease from the United States has been continued. Indications point to a successful issue of the campaign if prosecuted as now projected. Our efforts have comprised: — (1) Extension laboratory service; (2) Cooperation with other agencies animated by the same motives; (3) Direct pleas to the Federal government urging adequate appropriations; (4) Publication of the viewpoint of the Arboretum on the subject in a separate issue of its "Bulletin"; (5) Maintenance of a field laboratory on Long Island, N. Y.; (6) Researches on native wilt diseases of elms.

As matters of routine the laboratory has responded to a large number of inquiries on the diseases of many kinds of trees and shrubs, further developed its herbarium and reference collections and contributed a course at Harvard College on the pathology of woody plants.

Among the year's published results of investigations conducted by the laboratory special mention should be made of the following: (1) A preliminary paper by D. B. Creager throws light on the etiology and means of control of "Cephalosporium wilt disease" of elms. This disease is frequent and in some regions abundant from Minnesota to Maine and southward. Not only does it occur in established plantings but it has been and is unwittingly distributed from some nurseries because of existing lack of understanding of its nature and importance. (2) A paper by Dr. L. M. Hunter, monographic in scope, presents for the first time a detailed, systematic account of the morphology and the ontogeny of the spermogonia of the rust fungi that attack conifers. It is an admirable contribution to descriptive taxonomy; it also shows how certain species and genera can be distinguished from one another on their coniferous hosts alone — something that heretofore has often not been possible. (3) Three other papers, from Drs. J. H. Faull, I. H. Crowell, J. D. MacLachlan, respectively, materially extend our knowledge of the biology and the control of rusts of coniferous and pomaceous plants. One paper, dealing with two spruce rusts long known on their angiospermous hosts only, records experimental data showing that they alternate on spruces. The remaining two are significant, contributing as they do to a comprehensive understanding of Gymnosporangium rusts that alternate between Juniperus and pomaceous hosts and demonstrating practical means of control without having to resort to elimination of the alternate hosts.

Of the several researches that have been in progress, mention should be made of Dr. J. D. MacLachlan's work on a devastating disease of certain Myrtaceae, particularly pimento, the experimental part of which was carried out in Jamaica under the tenure of a Sheldon fellowship and in coöperation with the Jamaican government. He has solved the problem and showed that temperature is the decisive factor governing the spread of the disease. It is now clear that this crop asset, supposedly lost, can be perpetuated by establishing plantations at warmer levels (below approximately 1500 to 2000 feet altitude). Moreover, MacLachlan's findings with regard to the temperature factor call attention to a feature which probably influences the development of many other rust species.

The work of the laboratory has received generous recognition and support from various quarters. One result is a stimulus to effort. Another is provision for investigations otherwise not possible. Financial help, which is deeply appreciated, has come from the North Country Garden Club of Long Island, Mrs. Harold I. Pratt, the Massa-

chusetts Society for Promoting Agriculture, and the Noanett Garden Club.

Cytogenetic Laboratory.—The work on cytotaxonomic problems during the past year includes an analysis of American species of *Iris* by Dr. R. C. Foster, additional work on the Gymnosperms by Dr. Walter S. Flory, and an analysis of triploid varieties of *Malus* by Dr. Haig Dermen, and a study of polyploidy and geographic distribution in *Spiraea*.

Considerable work has been done on the experimental production of polyploidy. Extreme temperature variations produce chromosome doubling in the male gametes of *Rhoeo* and *Tradescantia*. Experiments involving the fertilized egg cells are in progress. Polyploid plants frequently are more vigorous and hardy than diploids, and the experimental production of polyploids may be of considerable practical value.

Work on chromosome structure in relation to meiosis and genetics has been continued. Dr. J. G. O'Mara has found that major coils in meiotic chromosomes can be suppressed by temperature treatment, and that these major coils are not a factor in chiasma formation. Relational coiling has been studied by Dr. L. Husted, who has used X-Ray-induced ring chromosomes for his analysis. The relational coiling in *Trillium* and *Vicia* has been studied finding that the direction of relational coiling is approximately at random for homologous chromosomes. This analysis is of interest in relation to the mechanism of crossing over. An analysis of chromosome behavior in relation to crossing over was presented at the 6th International Botanical Congress at Amsterdam.

The breeding work with ornamental shrubs has resulted in a number of hybrids which flowered this year. Many of the hybrids were made between American and Asiatic species, and these should be of value in a study of factors in speciation. Some of the hybrids should be of horticultural value.

The Herbarium.— During the past fiscal year 21363 specimens were distributed into the herbarium, bringing up the total to 430,062 mounted sheets. Of these accessions 6575 came from China, 5134 from Central and South America including Mexico, 2538 from Malaysia and India, 2167 from Australasia and 1330 from Africa.

Among the more important collections received during the last fiscal year may be mentioned 6647 specimens (including duplicates) from Hainan and Kwangtung, 3320 from Kwangsi and 1712 specimens from

Hunan, received from Lingnan University; about 10,000 numbers collected in Yunnan by H. C. Tsai, received from the Fan Memorial Institute; about 3000 numbers with many duplicates from Hainan, received from Sun Yatsen University; about 700 numbers with 5000 duplicates from Hunan received from the University of Nanking; 1280 numbers from Mexico collected by C. H. Mueller; 1369 numbers from Brazil collected by B. A. Krukoff; over 500 numbers of Brazilian plants collected by Riedel from 1831 to 1834, received from the Botanic Garden at Leningrad; 348 numbers from South America collected by Y. Mexia; over 200 numbers from Costa Rica collected by Alexander Skutch; 2095 numbers from Java and other Malayan islands received from the Botanic Garden at Buitenzorg; about 300 numbers of Malayan plants received from the Botanic Garden at Singapore; over 2000 Formosan plants collected by U. Faurie presented by Professor Oakes Ames; about 200 numbers from Central Asia received from the University at Taschkent; 510 numbers of European willows received from the Naturhistoriska Riksmuseet in Stockholm.

The fruit collection now contains 8432 specimens, 53 having been added during the year. Additions to the wood collection numbered 105 specimens bringing the total up to 3891.

The collection of photographic negatives of types and critical specimens, chiefly Chinese, now amounts to 3312 numbers, 300 having been added during the year. An alphabetical list of these has been prepared which will be sent on application to institutions desiring to exchange or to purchase prints.

During the year 2376 duplicates were distributed on our general exchange accounts and 1362 mounted sheets were loaned to specialists in Europe, America, and Asia for critical study.

Besides the constant use of the herbarium by members of the staff and also of other departments of the University for determination of plants sent in for identification, and of large collections chiefly from eastern Asia, the facilities of the herbarium have been used by visitors, among whom may be mentioned: Dr. N. C. Fassett, University of Wisconsin, Professor H. W. Rickett, University of Missouri, Professor Marie-Victorin, University of Montreal, Miss Alice Eastwood, California Academy of Science, Professor Wayne E. Manning, Smith College, Northampton, Mass., Dr. Clement G. Bowers, Maine, New York, Mr. F. Kingdon Ward, Cleeve, England, and Mr. Paul Russell of the U. S. Department of Agriculture, Washington. Dr. Lawrence Ames of the U. S. Department of Agriculture, Washington has been provided with working quarters throughout the year.

Members of the staff have been engaged in work on special subjects. Dr. E. D. Merrill has identified various large collections from southeastern China. Professor A. Rehder has identified several collections from the Kwangsi province and has continued his study of the ligneous Léveillé plants from eastern Asia. Dr. I. M. Johnston has continued his study of Boraginaceae and his identification of a large collection of plants from Chile; he also has written an account of South American species of *Astragalus*. Dr. H. M. Raup has worked up his collections made in the Athabaska–Great Slave Lake region, of which an account is being published in this Journal. Dr. C. E. Kobuski is continuing his study on the genus *Eurya* and Dr. Caroline K. Allen her work on the Chinese Lauraceae. Mrs. S. D. McKelvey has practically finished a monographic study of one group of *Yucca*. Mr. E. J. Palmer is continuing his revision of the American species of *Crataegus*.

Dr. Raup spent the entire summer of 1935 collecting in the Athabaska Lake district of northern Canada, and studying the distribution of types of vegetation in that region. The expense of this work was met in large part by a grant from the Milton Fund. About 1120 numbers of vascular plants were collected, averaging about 4½ specimens to the number. In addition, about 60 numbers of fungi and about 40 of seeds were gathered, and a large collection of lichens and mosses was made. He devoted most of the winter to the determination and study of these collections, and to the preparation of the first half of a catalogue of the flora of the Athabaska–Great Slave Lake region. In this catalogue 11 new species and varieties are described, most of them collected during the 1935 explorations. His study of local climatic conditions in the Arboretum was continued throughout the winter. This consisted mainly in taking temperature records each day at three localities selected as being the most significant of those studied during the previous year.

In September 1935, Professor A. Rehder attended the International Botanical Congress at Amsterdam and took the opportunity to visit the herbaria at Edinburgh, Kew, Paris, Berlin, Leiden and Utrecht, bringing back photographs of types of about 230 plants, mostly Chinese.

Botanical exploration, partly financed by the Arnold Arboretum has been prosecuted in Mexico and in China. Mr. C. H. Mueller again visited the Sierra Madre Oriental, in northeastern Mexico, as mentioned in last year's report and returned in August with a collection of about 450 numbers. The expedition, under Mr. C. H. Wang, sent out by Professor H. H. Hu from the Fan Memorial Institute to Yunnan, partly to regions not touched by Handel-Mazzetti or Forrest, collected

about 8,000 specimens. Lingnan University had several collectors working under the direction of Dr. F. P. Metcalf in the Kwangtung province, who gathered about 10,000 specimens. An expedition of the University of Nanking, under the direction of Dr. A. N. Steward, collected during the summer and autumn about 700 numbers in Hunan.

Following the plan developed at the New York Botanical Garden, a start has been made in inserting clipped or typed original descriptions, critical notes, illustrations, etc. in the herbarium, pasting them on the outside of the specimen covers. This will eventually entail a general reorganization of the herbarium and a universal use of the specimen covers which were formerly not used at all. Descriptions appertaining to non-woody plants are transmitted to the Gray Herbarium. In acquiring material for the herbarium, a working arrangement has been made with the Gray Herbarium, whereby one institution will not subscribe to a set of plants that the other has ordered, this plan in general favoring the Gray Herbarium for American material and the Arnold Arboretum for Eurasian collections. The actual transfer of reference collections on permanent deposit as between the two institutions has been discussed, but until additional storage space becomes available in both units, no extensive consummation of such a plan is possible.

The Library.—The total number of publications is now 42,547 bound volumes, 11,476 pamphlets, and 17,762 photographs, 522 bound volumes, 559 pamphlets and 179 photographs having been added during the year. A total of 10,023 cards were prepared and distributed into the various indices, while 2815 slips were filed in the supplement to the author and subject catalogue to the library, making 22,805 ready for publication. Professor Oakes Ames presented 100 colored lantern slides, and through the generosity of Mrs. Louis A. Frothingham, Dr. Wyman was able to add 250 more, thus providing important facilities for members of the staff.

Forty-three new periodicals were added to the list of those currently received, these additions acquired chiefly by exchange, a few by gift; most of these are new ventures in the publication field having been commenced, for the most part, since 1930. Through the courtesy of Dr. R. Kanehira, we were fortunately able to acquire a complete set of the Journal of Japanese Botany, the early volumes of which are out of print and very difficult to secure. A number of important independently published volumes were acquired by purchase, exchange, and gift, thus adding to the resources of the library.

The library continues to attract seekers for information, 425 having

registered during the year. The policy of sending out inter-library loans has been continued, as this is advantageous to individuals living at a distance as well as to our own staff members who occasionally have need to consult works that are not represented in any of the libraries in or near Boston, which through the inter-library loan system we are often able to borrow for limited periods. When books could not be loaned, we have supplied typewritten excerpts or photostat copies.

To facilitate work in the herbarium and to save time of staff members, shelves were constructed at the ends of the herbarium cases on all the floors of the main herbarium and about 800 constantly used volumes were transferred to this new location thus relieving to a considerable extent the overcrowded shelves in a part of the library proper.

During the year, the usual numbers of the Journal and of the Bulletin of Popular Information were issued as well as one number of the Contributions.

Atkins Institution of the Arnold Arboretum, Soledad, Cienfuegos, Cuba. Mr. Robert M. Grey who since 1899 has constantly been associated with the plantings at Soledad, retired on June 1, 1936 the University granting him the title Superintendent, Emeritus. Mr. Grey, originally employed by Mr. Atkins to direct sugar cane breeding work, was unusually well qualified by training, experience, and inclinations to develop the planting program at Soledad. To his continuous and efficient efforts over a period of 36 years we are largely indebted for the present extensive gardens and for the comprehensive collections of tropical plants now growing at the Atkins Institution. His record of achievement was a remarkable one both in the field of plant breeding and in that of the introduction and establishment of exotic species. In 1933 the published list of species grown at Soledad approximated 1970 species. Additions from 1933 to 1935 through the combined efforts of Mr. Grey, Mr. Walsingham and other interested parties approximate 2470 species and varieties.

On the termination of Mr. Grey's long term of service we were particularly fortunate in securing as his successor the services of Mr. David Sturrock, who was appointed Superintendent in June, 1936. He is a widely experienced plantsman with 12 years actual experience as a resident of Cuba. Under his leadership it is confidently expected that rapid development and a further expansion of the already extensive plantings at Soledad will result.

The total rainfall at Soledad during the year was 55.73 inches, somewhat above the annual average. This was reasonably well distributed,

the plantings not suffering appreciably from drought at any time. While the weather conditions were generally conducive to normal growth, unfortunately cyclonic winds proved to be destructive on three occasions, July 26, Sept. 3, and Sept. 27–28, 1935. The first two storms were of minor importance but the last was the most disastrous hurricane ever recorded at Soledad. Its results were extremely devastating. The high winds with a velocity of from 80 to 90 miles per hour, or at times even higher, continued for over five hours. The lowest barometer pressure was 28.48 inches at 3 A. M. Sept. 28.

Surprisingly little rain accompanied this storm. Many of the fine old trees were uprooted or badly broken, and with few exceptions all were denuded of their foliage. Many large palms were blown down or their tops were snapped off. In the injured trees it was observed that, in due time, some sprouted vigorously from near the base while the upper parts died or produced only a stunted growth. On the south side of many trees the bark appeared as though it had been burned into the cambium layers; this later caused the death of several species.

After the storm 72 cords of heavy wood and over 200 ox-cart loads of fallen branches and other débris were removed, this giving some graphic idea of the wreckage and the extra labor required to bring the garden into a somewhat presentable condition following the storm. A generous donation from Mrs. Atkins and the transfer of a similar amount from Arboretum funds provided the means by which the rehabilitation work could proceed without delay.

Following the storm necessary repairs were made to Harvard House and other structures. New construction includes the new seboruco dam and bridge, and a new road along the west bank of the arroyo below the cycad collections. The boundary fences have been repaired and small extensions made to the water distributing system. Much time had to be devoted to relabeling the arboretum specimens as over 200 labels were lost during the hurricane and others were in poor condition. The improved labels now used are much more satisfactory than the old ones being more durable and more economical than those formerly used.

Large additions were made to the succulent collections, chiefly through the Harvard Botanic Garden, the N. Y. Botanical Garden, and La Mortola Garden in Italy. The orchid collections have received extensive additions, particularly those sent by Mr. C. H. Lankester from Costa Rica, about 350 species now being represented. The rock garden has been increased to twice its former size. The lily, amaryllis, and ginger collections were transferred to a better location.

The seed and plant exchange program has been continued. Over 650

living plants, including 246 orchids, 95 cuttings, and 345 packets of seeds were received from various institutions and individuals thus adding many new and valuable species to the living collections. Large collections of living plants, bud wood, and cuttings, as well as 471 packets of seeds were distributed in connection with the general exchanges of such material.

Over 250 species represented by about 750 specimens were labeled, hardened up out of doors, and planted in various parts of the arboretum. The spring plantings were commenced April 17, following the first heavy rains, and completed on May 25.

In general, in addition to the heavy rehabilitation burden entailed by the destructive hurricane of Sept. 27–28, routine garden work such as cleaning, weeding, mowing, pruning, the eradication of diseases and insect pests, watering when necessary, and other incidentals have been given the usual attention.

Professor Thomas Barbour, Custodian, as usual spent several weeks at Soledad in February, arranging for the necessary repairs to Harvard House and conferring with Mr. Grey as to which damaged trees should be removed entirely and what should be pruned and allowed to rehabilitate themselves, and going over the collections at Harvard House to be sure of their freedom from pests, and to check their general condition after the storm. He is also publishing a report on the destruction of birds by the storm.

During the year Dr. Philip Darlington continued entomological studies which he had begun on previous visits. Professor J. H. Faull spent several weeks studying fungous diseases of the pimento tree and allies. Messrs. R. H. Goodwin and A. L. de Lisle, both graduate students, visited the Garden on University Fellowships to gather material for study in Cambridge. Dr. A. G. Kevorkian spent some time studying aquatic fungi and had the experience of being at the Laboratory during the great storm.

During the fiscal year 1935–36 grants or fellowships have been awarded to six students whose work at the Garden will be noticed next year.

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ALFRED REHDER, A.M., Associate Professor of Dendrology and Curator of the Herbarium.

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ETHEL ANDERSON ALLEN, Business Secretary.

LOUIS VICTOR SCHMITT, Superintendent.

WILLIAM HENRY JUDD, Propagator.

CORRECTIONS

Page 69, under **Castanopsis Eyrei** omit the synonyms *Castanopsis neo-Cavaleriei* and *C. tribuloides* var. *echidnocarpa*.

" 118, line 7 for **Faulliana** read **Faullianum**.

" 198, line 3 from below for **Saggitaria** read **Sagittaria**.

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